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PHYSICIAN-INDUCED DEMAND
FOR SURGICAL OPERATIONS

Final Report

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by

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ABSTRACT

Policymakers have become increasingly concerned that the discretionary ability of physicians to shift demand has resulted in unnecessary utilization and excessively high fees. This study sought to directly test the inducement hypothesis, using surgery as a test case. Analyses were based on a cross-section time-series of NCHS Health Interview Survey data for 1969-1976. Holding all other factors constant including prices, surgeon supplies were found to induce demand: a 10 percent increase in surgeons per capita resulted in a one percent increase in total surgery rates, and a 1.3 percent increase in elective surgery. Most of the inducement effect, however, comes through higher surgeons' fees, about $50 per operation more. Long-run fee elasticities actually exceed short-run elasticities (+0.90 vs. +0.36). This paradox is resolved when the sample is decomposed into rural, small, and large urban areas. Rural areas resemble the traditional competitive market: there is no evidence of inducement and fees fall with greater surgeon concentration. Large SMSAs, by contrast, show a definite backward bending supply curve, so that outward supply shifts result in movements back along the induced demand curve and significantly higher fees. Additional analyses, using a disequilibrium approach and segmenting the markets into surgeon surplus and shortage areas, provided further evidence of inducement. The usual competitive mechanism of price adjustments to eliminate demand-supply gaps appears strangely altered, if not missing altogether, in the market for surgical services. These findings suggest that many traditional policy tools, including fee regulation and utilization review, will only worsen the situation and that new reimbursement approaches, such as capitation, may be needed.

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J. M.

J. C.

I. EXECUTIVE SUMMARY

As everyone already knows, medical care in the United States is an expensive proposition, and growing more so every day. Total health expenditures in 1978 were $192 billion, or 9 percent of the Gross National Product (HCFA, 1980). The federal share alone was $46.5 billion, with a compound annual rate of increase of 17 percent from 1965 (Davis, 1977; HCFA, 1980). At the beginning of 1978, the government was writing $5.3 million dollars worth of checks to medical care providers every hour of every day of the year. By the end of 1978 these hourly checks had risen by $900,000 to $6.2 million, or $7.9 billion more on an annual basis.

It is generally recognized that a large proportion of these health care costs can be traced to the physician, either directly through physician services (e.g., office visits, operations) or indirectly through hospital admissions, laboratory tests, and other procedures ordered by the physician. Expenditures on physicians' services alone were $35 billion in 1978, a 161 percent increase from 1970 (Dyckman, 1978), with Medicare and Medicaid paying $4.69 billion and $2.33 billion, respectively. This dramatic increase in physician expenditures can be decomposed into two parts: fee inflation and increased utilization. From 1970-1976, physicians' fees rose 7.8 percent per year compared with only 6.5 percent annually for all non-medical care prices (Dyckman, 1978). During 1977, the rate of fee increase actually accelerated: 9.2 percent compared with 6.6 percent for non-medical care items in the Consumer Price Index. At the same time, physician utilization has been rising nationwide. The _per capita_ number of surgical operations, for example, increased 31 percent, from 71 per 1,000 population in 1968 to 93 per 1,000 in 1977 (NCHS, 1973; unpub.).

Spiraling health care costs in the last decade has left many unanswered questions concerning the most effective way of providing health services to millions of Americans. Of particular concern is the appropriate level of care: Are there too many physician visits, surgical operations, and hospital days? Could reductions in utilization be achieved without seriously reducing access to needed care and health outcomes?

The government has three potentially powerful tools at its disposal in controlling medical care expenditures: (1) controlling the supply of physicians; (2) physician fee setting; and (3) appropriateness review. If physicians are able and willing to "shift" demand for their services, however, these policies may lead to unanticipated results.

Recent federal health manpower policy has been aimed at expanding the supply of physicians and improving access to care for rural and inner-city residents. If physicians can generate demand for their services, however, supply-side policies may have the perverse side effect of escalating health expenditures through increased utilization for all population groups. Unlike conventional economic markets, there is little evidence that competition in the medical marketplace will drive down prices, particularly given comprehensive health insurance coverage and a technological imperative.

Manpower experts have been dismayed-- to say the least-- at the downward price rigidity in the physician market in spite of large manpower increases. While some still argue that a big enough increase in supply will exhaust any discretionary shifting and reinstitute meaningful price competition, can reimbursement agencies run such a risk? Does a saturation point even exist?

If so, at what physician-population ratio and how much will it cost the country to find out?

Direct regulation of physician fees is an attractive alternative to expanding supply. If high fees are the problem, why not attack the problem head on by restricting fees for Medicare and Medicaid patients? But if physicians can shift demand, they may offset declining prices with increased utilization, leaving total expenditures unchanged. Physicians could exert enough discretionary power that average fees for all patients would rise, along with gross expenditures for physician care. Supplementing fee regulation with utilization review, while a logical reaction, may extend regulation beyond the point of diminishing returns.

The Surgeon "Problem"

The rapid expansion in surgeon supply over the past decade presents a special case of the general problem of medical care inflation, particularly if surgeons are able and willing to shift demand to preserve workloads, fees, and incomes. The number of board-certified surgeons, who perform over half of all major operative procedures in the United States, rose 23 percent from 1969 to 1978 (ACS, 1975). We have yet to see the full impact of this expansion on utilization and expenditures because (a) the period of rapid growth in medical school enrollments (1965-1978) is just now drawing to a close, and (b) it takes a surgical specialist approximately 18 years from the time of medical school graduation to reach his maximum operative workload (Nickerson et al., 1976b).

Anticipating large increases in practicing surgeons in the future, it is important to determine the extent to which surgeon supply influences surgery rates, fees, and total expenditures on surgery. Specifically, our study provides new information in several areas related to surgeons:

(1) How do surgery rates and fees vary across small areas in the United States;

(2) How fast have surgery rates and fees been increasing over time, both nationally as well as in rural and urban areas;

(3) In what respects are surgery rates and fees (along with other market characteristics like workloads) related to the number and growth of surgeons in an area; and

(4) What evidence exists in support of the generally-held notion that physicians (including surgeons) have discretionary power over demand.

Surgery was chosen to test for inducement for several reasons. First, the product, a surgical procedure, is more homogeneous than other physician services. Office visits, on the other hand, may vary greatly from physician to physician in their content and intensity in ways that could be systematically related to the extent of competition. Second, the demand for surgery should be less sensitive to amenities provided by the physician (e.g., waiting rooms, visit lengths), a factor otherwise difficult to control for due to data limitations. Third, surgery is a controversial topic in health care circles today precisely because of alleged incentives encouraging surgeons to perform unnecessary operations. A disadvantage of surgery as a test of inducement is its relatively large, non-elective component. If inducement can be demonstrated for surgery, it is likely to be even more prevalent in other kinds of physician services (e.g., follow-up office visits, ancillaries).

Data Base

Issues pertaining to surgical utilization and cost were addressed with a cross-section time series, using NCHS Health Interview Survey data for 1969-1976. The Health Interview Survey included 42 reels of information on individual sociodemographic characteristics, family income, hospital episodes, and types of surgical operations. Annual surgery rates (excluding obstetrical procedures) were based on over 100,000 individuals located in 349-360 Primary Sampling Units (PSUs) nationwide. Indices of surgeons' fees were constructed based on Medicare prevailing charges for six commonly performed procedures using the national procedure mix as weights. Additional data, such as the supply of surgeons and community characteristics, were merged on at the PSU level. The final data base included over 2800 PSU-years worth of data on several hundred variables. The reader is referred to Chapter V of the Final Report for more detail on how the data base was constructed.

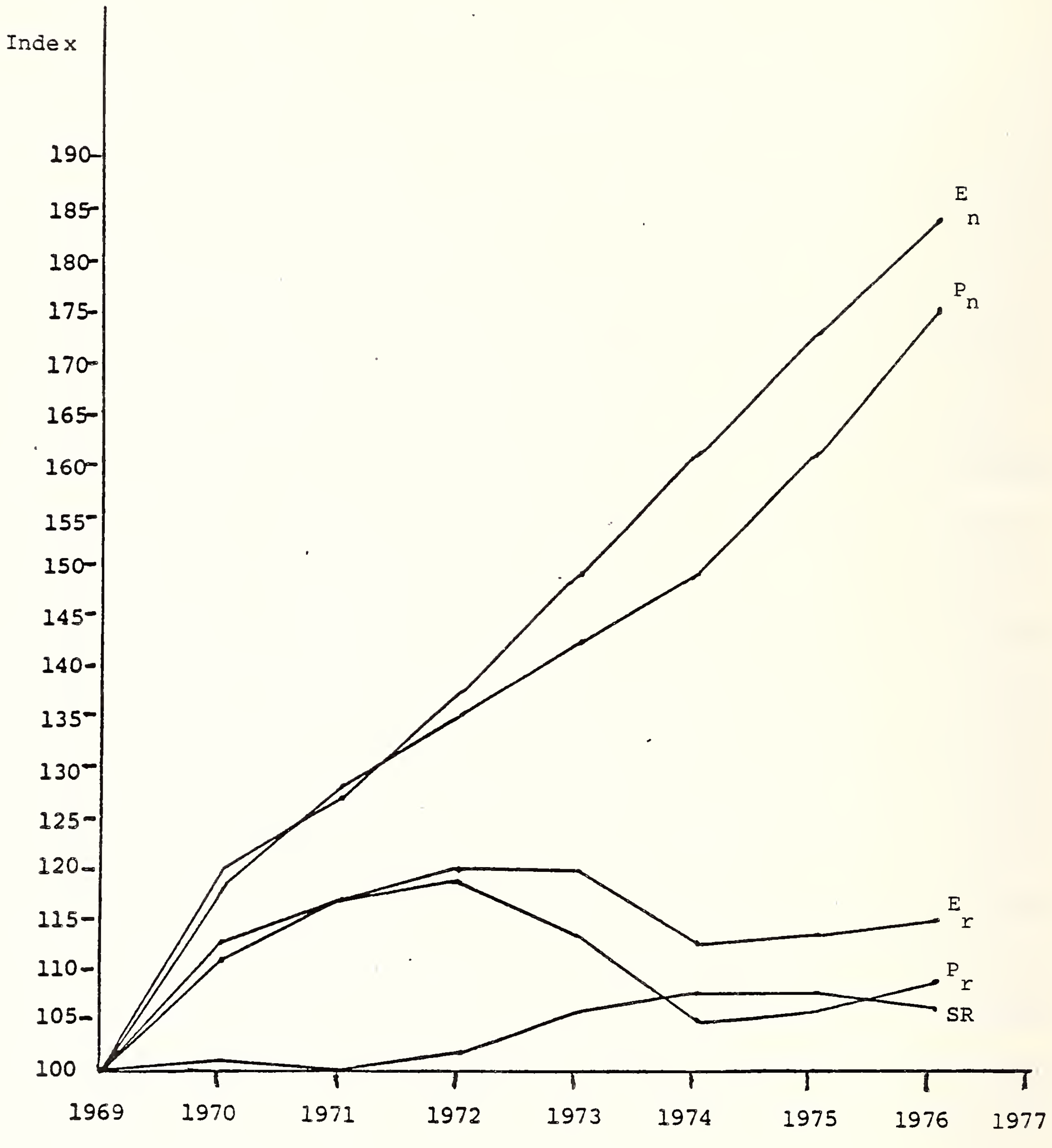
Descriptive Findings

National Trends

National expenditures on the physician component of surgery increased 84 percent in nominal terms between 1969 and 1976, adjusted for population growth and changes in the age-sex distribution (see Figure I-1, line E_n). Surgical fees increased 75 percent, from $283 to $495, while total surgery rates (excluding deliveries) increased 6 percent, from 59.6 to 63.2 operations per 1,000. While most of the increase in fees can be attributed to a 65 percent increase in the general price level, it is remarkable that deflated surgical fees still increased by 9 percent. This increase is even more remarkable when one takes into consideration the 12 percent increase in surgeons per capita, which theoretically should put downward pressure on fees. After deflating fees, the contribution of price and quantity to expenditure increases are on the order of 3:2 (viz., 9 to 6 percent).

While surgeons' stated fees increased throughout the period, the trend in deflated fees rose 19 percent from 1969-1972, fell 14 percent from 1972-1974, then slowly began to rise again in 1975 (see Figure I-1, line P_r). Wage-price controls, in effect from the latter half of 1971 to May 1974, evidently

FIGURE I-1: GROWTH IN SURGICAL EXPENDITURES, FEES, AND SURGEON SUPPLY



KEY: E_n=nominal surgical expenditures per capita

E_r=real surgical expenditures per capita

P_n=nominal surgical fees

P_r=real surgical fees

SR=total surgery rate (age-sex adjusted) constrained surgeons' fees to a greater extent than other prices, leaving the surgeon--like most workers-- with a lower real income.

The minor increase in total surgery rates can be explained, in part, by a small decline in elective surgery rates of 3.5 percent (see Chapter V of the Final Report for a definition of "elective"). Ours is likely an underestimate of total elective surgery because of incomplete reporting. Nonetheless, the verified declines in some of the more popular elective procedures are noteworthy: tonsillectomies, down 46 percent from 1968-1977; varicose vein excision, down 40 percent; hemmorhoidectomies, down 21 percent (NCHS, 1973 and unpub.). As our period essentially precedes the widespread implementation of PSROs, other factors must have been responsible for these declines (e.g., changing medical attitudes, improved consumer awareness).

Finally, surgeons' fees represent only the smaller component of surgical expenditures: hospital costs average about three times as much. If we include hospital charges, total expenditures on surgery in 1976 come to $21 billion (in 1969 dollars), up 43 percent versus only 15 percent for the surgeons' costs alone. As high as it is, this number is an underestimate given the exclusion of obstetric cases from our figures and the decidedly lower reported HIS surgery rates. Furthermore, surgical patients were assumed to incur the same hospital bill as other patients which is also likely to understate the case.

Regional Trends

National trends, while of general interest, were of less concern in this study than regional variation, for it is the latter that most sheds light on possible areas of overutilization and noncompetitive pricing. Previous small-area studies of surgery rates discovered wide variations within a given state (Lewis, 1969; Roos, et al., 1977; Wennberg and Gittelsohn, 1973; 1975). Our data, using 350 PSUs nationwide, confirm this variation at a national level as well. Roughly one-third of all PSUs exhibited total surgery rates at least 20 operations per 1,000 population above or below the sample mean of 63. Elective surgery rates showed even greater small area variation, as expected. These rates have already been adjusted for local age and sex differences that might otherwise explain differences among PSUs. Furthermore, they are population-based and therefore include all operations experienced by PSU residents (including those instances where patients journey elsewhere for care).

What explains such wide variations? Surprisingly, these differences are not systematically related to region of the country, or to degree of urbanization. Compared with hospital utilization (admissions and mean stays) which does vary strongly by region, surgery rates exhibit very little variation at the census division level. This suggests that factors associated with regional differences (e.g., medical practice, consumer attitudes, etc.) are of less importance than otherwise thought. Within regions, surgery rates are roughly comparable across rural, small, and large metropolitan areas, at least by 1976 (see Table I-1). Differences that did exist in 1969 were significantly narrowed by higher rates of change in non-metropolitan areas over the time period. Table I-2 provides a graphical illustration of these time trends. From 1970 to 1975, surgery rates increased 12.0 percent in rual areas versus 1.1 and 5.6 percent in small and large SMSAs, respectively. As can be seen in Tables I-1 and I-2, this catching-up process in rural areas is largely attributable to the influx of new surgeons, which was dramatically higher than in urban areas-- at least in percentage terms. Despite this influx, however, the absolute number of surgeons per capita was still only half that in SMSAs (188 vs. 371 per 100,000 in rural areas and large SMSAs).

A relatively constant surgery rate across metropolitan and non-metropolitan areas, coupled with wide variations in practicing surgeons, suggest a low overall

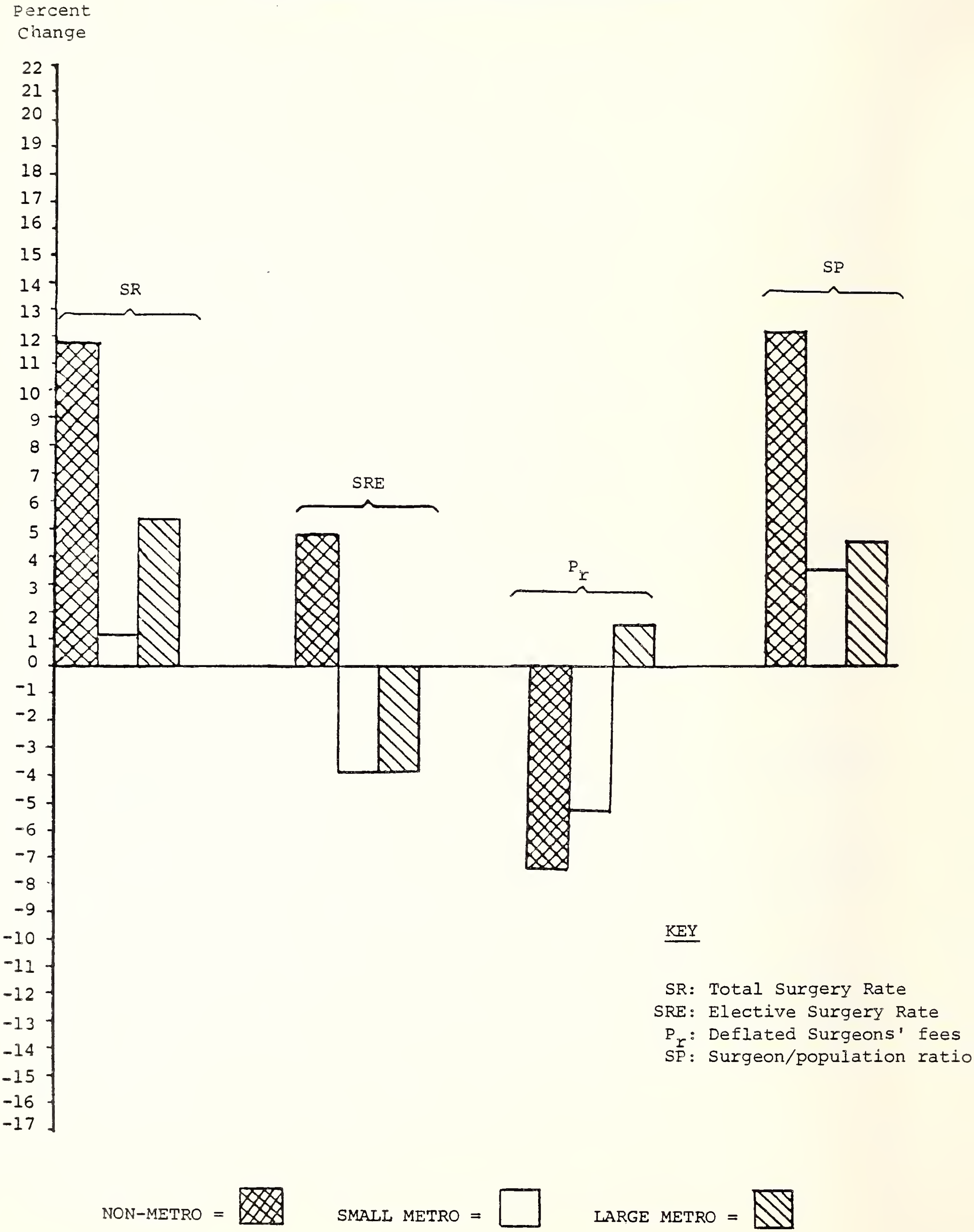
TABLE I-1:

CHANGES IN SURGERY RATES, SURGEON SUPPLY AND FEES ACROSS LARGE, SMALL, AND NON-METROPOLITAN AREAS

	Non	Small	Large	Percent Change		
				Non	Small	Large
Total Surgery						
1970	57.3	62.0	60.9			
1975	64.2	63.7	64.3	12.0	1.1	5.6
Non-elective Surgery						
1970	28.2	30.5	29.0			
1975	33.7	33.4	33.6	19.5	9.5	15.9
Elective Surgery						
1970	29.1	31.5	31.9			
1975	30.5	30.3	30.7	4.8	-3.8	-3.8
Surgeon Supply						
1970	.168	.343	.355			
1975	.188	.355	.371	11.9	3.5	4.5
Deflated Fees						
1970	$316	$306	$327			
1975	$292	$290	$332	-7.6	-5.2	1.5

Note: 1970 and 1975 numbers based on 3-year moving average.

TABLE I-2: PERCENT CHANGES (1969-1976) ACROSS LARGE, SMALL, AND NON-METROPOLITAN AREAS

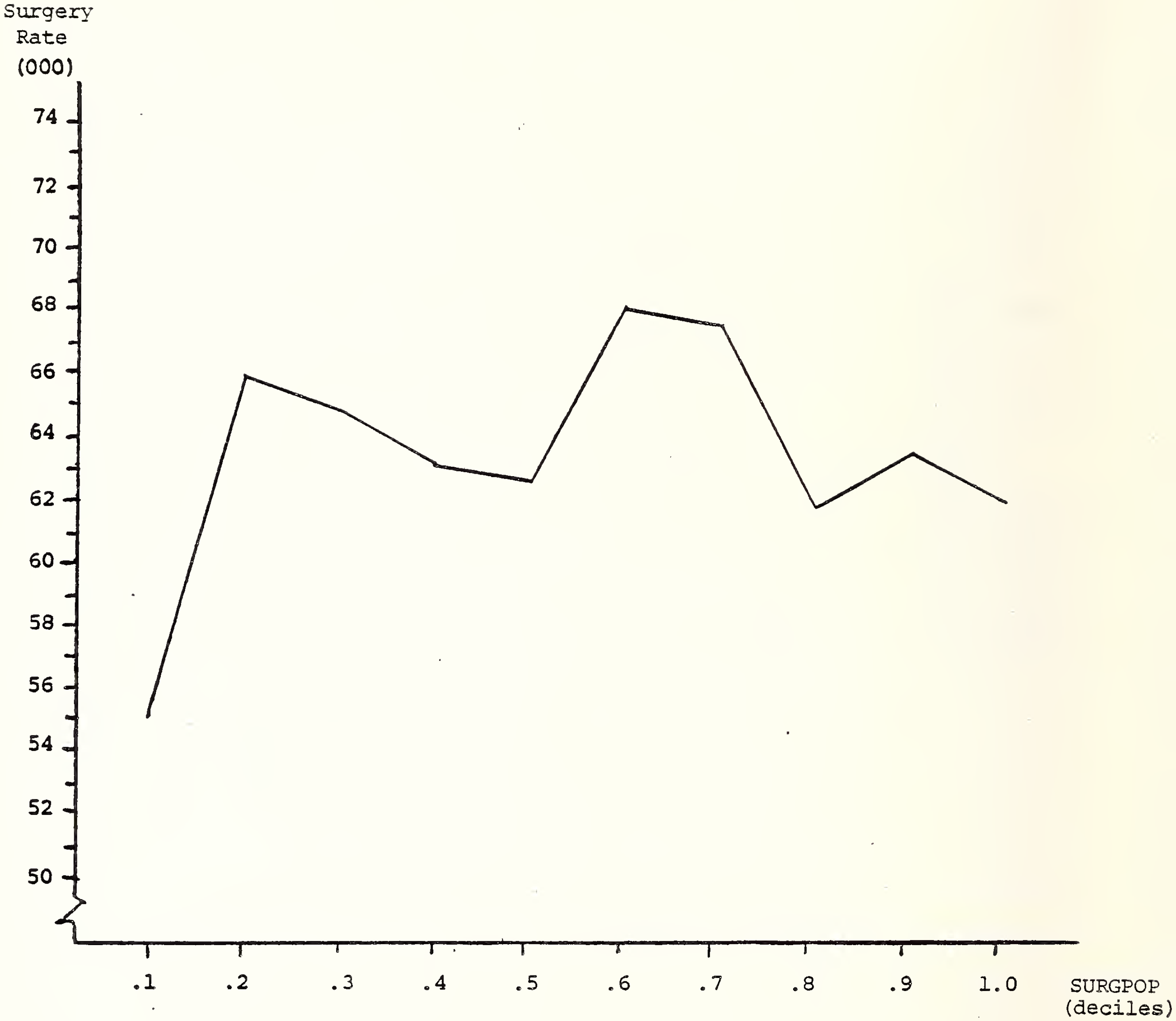


correlation between supply and utilization. Figure I-2 plots total, age-sex adjusted surgery rates against low-to-high deciles of surgeon concentration. The horizontal axis groups the 349 PSUs in 1976 into ten deciles according to their surgeon-population ratios. Thus, .1 constitutes the mean surgeon-population ratio for the lowest 10 percent of PSUs (18, in fact, had no surgeons). What is particularly striking is that, with the exception of the very lowest 10 percent, surgery rates do not systematically vary with surgeon concentration. Surgery rates in the top three deciles, if anything, are lower than in areas with fewer surgeons. This pattern is essentially the same for elective surgery rates (not shown).

A threshold clearly exists at the lower end, however, that evidently explains much of the observed positive correlation between surgeon supply and utilization. Below about one surgeon per 20,000, utilization drops off considerably. A closer investigation of "shortage" areas (narrowly defined as PSUs without any surgeons) showed that all of the reduction was in terms of elective operations; shortage areas averaged 25 discretionary procedures per 1000 compared with 31 for other rural areas. No significant differences were found in non-elective or "necessary" surgery. Furthermore, the influx of surgeons in rural areas over time has reduced the percent of PSUs without a surgeon by two-thirds, from about 12 to 4 percent, suggesting that even the gap in elective surgery will be closed rapidly.

Positive surgery rates in areas without surgeons reflect both the substitution of non-surgeons (mostly general practitioners) for surgeons, and patient migration to other areas for surgical care. Surgeon-scarce areas, primarily in rural America, do have more GPs per capita; roughly 25 percent more than in surgeon dense areas. We also find many of them in close proximity to small SMSAs with significant numbers of surgeons. The additional travel time required does pose

FIGURE I-2: CORRELATION OF SURGEON DENSITY (SURGPOP) WITH SURGERY RATES



real questions of access, however, as does the more limited training of those GPs doing surgery.

A final comment on the descriptive results concerns surgeons' fees. Nominal fees have risen dramatically, not only for the nation as a whole, but also in every geographic region. Historically, they have also been higher in areas where surgeons are more plentiful, in seeming contradiction with competitive theories of price determination. No contradiction may exist in truth, however, if surgeons are drawn to areas where living costs are higher: all of the positive correlation between fees and supply may simply be an artifact of surgeons' locational preferences. Unfortunately, the explanation is not so easy. Nominal fees in surgeon-dense areas were indeed 36 percent higher in 1976 than in surgeon-scarce areas, $521 vs. $384. Adjusting for inter-area cost of living differences reduces the discrepancy, but only by about 50 percent (to 19 percent to be exact). Over time one might expect competition and physician migration to narrow the differential, but in fact the opposite has occurred (see Table I-1). Over the 1969-76 period, real fees fell 7.6 percent in relatively surgeon-scarce rural areas while they were rising 1.5 percent in the large, surgeon-dense, SMSAs.

Econometric Findings

Observed surgery rates and surgeons' fees are jointly determined by demand and supply factors. Factors that would increase consumer willingness and ability to pay for surgery, including health status and insurance coverage, should raise demand, surgery rates, and fees while increments in supply-side factors should raise supply, raise surgery rates, and reduce fees. Surgeon concentration, or surgeons per capita, as a supply-side element, should be positively correlated with surgery rates if patients are responsive to the lower prices presumably brought on by greater competition. Thus, care must be taken not to ascribe unethical motives to physicians who provide more services to independent consumers who have chosen to undergo elective surgery where competition (or more insurance or whatever) has made it more economical. "Pure" inducement should be reserved for outward demand shifts unexplained by other demand-side factors, as opposed to changes in the quantity demanded, which should increase as patients move down along a given demand curve in response to lower prices. That deflated fees are higher in surgeon-dense areas, while suggestive of inducement, is not conclusive either because other demand-supply factors are not being held constant. Multivariate econometric methods were used to adjust for these factors, thereby isolating the pure inducement effect, if any remains.

Two basic formulations of the model were used: one that assumed fees adjusted within the period to maintain equality between quantity demanded and supplied (the equilibrium analysis); and a second that allowed for fee rigidity and disequilibrium. The equilibrium model consisted of five equations: a demand, a supply, a workload, a surgeon location and an equilibrium equation. Surgery rates, surgeons' fees, workloads, and surgeon-population ratios were considered to be jointly determined, or endogenous. Fees, for example, depend on the number of surgeons competing while at the same time higher fees in an area should attract more surgeons, setting up a feedback effect. Simultaneous equation techniques were used to adjust for such feedbacks.

In addition to the four endogenous variables, many other, exogenous, variables were included to hold constant demand and supply factors that might be correlated with surgeon concentration. Demand factors were grouped into three categories: medical, sociodemographic, and economic. If physicians and patients based health care decisions only on medical need, then economic variables (income, fees, health insurance) would play no role. All evidence suggests this is not the case-- even for surgery. Supply-side variables were also grouped into three categories: non-surgeon supplies (i.e., GPs), cost- and productivity-influencing variables, and professional/residential amenities. Surgeon location was hypothesized to be a function of areawide fees, workloads, hospital bed supplies, and amenities. Three demand equations were estimated: one for total surgery, and two for non-elective and elective surgery separately. All monetary variables were deflated by an area cost-of-living index and expressed in 1969 dollars.

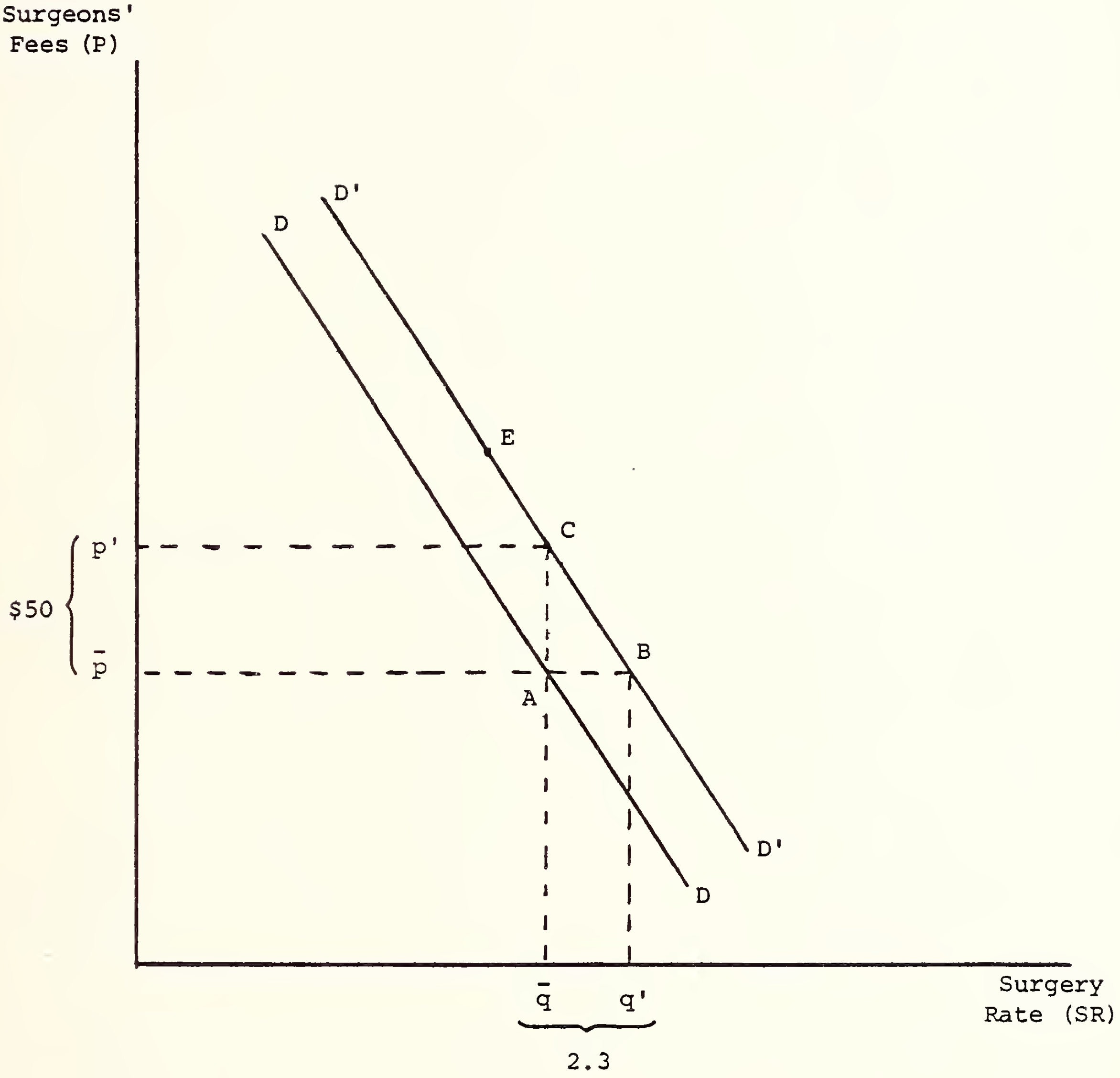
Equilibrium Findings

The demand for surgery as a whole was found to be significantly affected by the health status, age distribution, race, and educational status of the population as expected. A significant role for economic variables was also found, however, reinforcing the claim that surgical decisions are not based strictly on medical need. Income, surgeons' fees, and hospital costs all had a statistically important effect on surgery rates. The surgeons' fee elasticity of demand was -0.14 and -0.17 for total and elective surgery, respectively. Higher hospital charges per admission also lowered both rates, although the effect was quite small (an elasticity of -0.04). Insurance had little effect on utilization, most of its effect coming in terms of surgeons' fees.

Holding constant all other relevant factors including prices, surgeon supplies were found to induce, or shift, demand: a 10 percent increase in supply, ceteris paribus, led to a 1 percent increase in total surgery, and a 1.3 percent increase in elective surgery. All of the inducement in fact takes place with these discretionary operations; non-elective procedures alone were not significantly affected by surgeon availability. If supply were perfectly elastic with no increase in fees, areas one standard deviation (σ) above the mean would exhibit 2.3 additional operations per 1,000 population due to a rightward shift in demand from D to D' (see Figure I-3); composed of 1.7 discretionary and 0.6 non-elective operations. Based on average surgeon-plus-hospital 1976 deflated prices, this increase would amount to over $3 million per year in a city of one million. With a perfectly inelastic supply (implying workload declines exactly commensurate with the influx of new surgeons), average surgeons' fees would rise $50 per operation (from $\bar{p}$ to p' in Figure I-3). This represents a short-run fee elasticity with respect to surgeon concentration of .36 (compared to .10 for output).

Long-run fee elasticities should be lower if supply is increased, which will be the case if workload declines do not completely offset the influx of new surgeons. New equilibrium fees may or may not be higher than before (say, $\bar{p}$ in Figure I-3), depending on how much net supply increases. Thus, it is a paradoxical finding that the *long-run elasticity, estimated at .90, exceeds* the estimated short-run inducement effect by a considerable margin. Assuming equilibrium price-quantity combinations, this result implies less, rather than more, surgery with greater surgeon concentration (say, point E in Figure I-3). If true, the focus on excessive surgery allegedly induced by surgeons may be misplaced. What *is* more remarkable are the very high fees charged by surgeons in surgeon-dense areas, even after adjusting for other demand and supply factors.

FIGURE I-3: A GRAPHICAL ANALYSIS OF INDUCEMENT



When the sample is decomposed into rural, small, and large SMSAs, the paradox becomes a little clearer. Rural areas show no inducement and significantly lower fees where surgeons are relatively plentiful. Workloads are positively related to fees, and surgeons are quite sensitive in their location decision to higher fees (a location elasticity of 2.5). Large SMSAs, by contrast, show a definite backward-bending supply curve so that outward supply shifts result in movements back along the induced demand curve. Instead of lower fees with increased competition, increased supply together with demand inducement produces higher fees-- possibly due to price floors determined by the prevalence of usual, customary, and reasonable (UCR) reimbursement methods. While SMSA surgeons may take some of their higher fees in the form of extra leisure, much of their extra time is probably directed into non-surgical activity (e.g., teaching, research, consultation). The spillover effects this might have on prices and utilization of non-surgical physician services are unknown.

Disequilibrium Findings

The suggestion of implicit price floors prompted a consideration of a disequilibrium approach to resolving the paradox. If surgeons' fees are rigid downwards in surgeon-surplus markets, the true supply curve may not be directly observable. Supply may only appear backward-bending because utilization rates are demand constrained; surgeons would like to provide more at the higher fees but are limited in the extra output they can induce. If they have no inducement ability, however, surgery rates should be solely determined by demand factors.

While surgeons are usually considered to be in excess supply, some surgeon shortage areas do exist. Additions to surgeon supplies in these areas should result in a partial filling of the latent (unobserved) demand-supply gap and in increased surgery rates. In this case improved access, not inducement, is the reason for greater utilization, and no opprobrium should be attached to physician behavior. Pooling chronic surplus and shortage areas, therefore, could lead to spurious results. A dual segmentation of surgeon markets was made based on average workloads. In high workload, or shortage, areas, surgery rates should be determined primarily by supply factors-- particularly the number of surgeons per capita. Surgery rates in low workload or surplus areas, on the other hand, should not be related to supply factors like surgeons.

Expectations were confirmed for shortage areas as surgeon concentration dominated the observed surgery rates; of the many included demand variables, only poorer health status of the population was positively related to surgery. Surgery rates in surgeon-surplus areas, by contrast, were almost uniquely determined by demand variables like surgeons' fees, hospital prices, income, and age. Surgeon concentration, however, still showed a significant, positive effect on surgery rates (holding fees constant) although its effect was reduced compared to the pooled, equilibrium results discussed earlier (from an elasticity of .09 to .08). Nor was there any evidence that price competition is eliminating the shift through lower prices, as deflated fees were rising significantly faster in these surplus areas. In summary, the usual competitive mechanism of price adjustments to eliminate demand-supply gaps appears strangely altered, if not altogether missing, in the market for surgical services.

Policy Implications

The 1975 study of surgical manpower prepared by the American College of Surgeons (usually referred to as the SOSSUS report) found the current surgical manpower pool in the United States to be more than adequate, at least in terms of quantities if not quality and specialty mix. Low average workloads and few underserved areas were cited as evidence for the need to slow down the stream of new surgeons expected to enter practice in the 1980s. A strong plea was made in the report to circumscribe the practice of surgery to qualified (usually board-certified) surgeons by (a) reducing surgical residencies, (b) encouraging hospitals to tighten the credentialling process for surgical privileges, (c) limiting the inflow of lesser qualified foreign medical graduates, and (d) strengthening the periodic review of surgeon skills and competence. General and family practitioners in particular were encouraged to redirect their efforts away from surgery: "surgical training in family practice should be restricted to primary management and diagnosis of trauma, the provision of first aid, the establishment of sound referral practices, and emergency ward capability" (ACS, 1975, p.89). The authors also argued for care in regulating fees to preserve returns on the extensive human capital investments made by surgeons (p.88).

Regulators may legitimately question the ultimate impacts on competition of such restrictions in supply. With very price-inelastic demand, reductions in surgical residencies and FMGs may enable practicing surgeons to charge much higher fees and enjoy monopolistic incomes far beyond those that would obtain from freer entry. Even the SOSSUS report recognized this as a possible consequence of constrained supply and increased workloads.

Our results, on the other hand, provide little reassurance that significant additions to the surgical manpower pool will work to keep prices down. Extensive, UCR-based insurance coverage for surgery is a fact of life as is the discretion surgeons have over demand. Burgeoning supplies necessarily mean declining workloads which, combined with downward rigid fees and inelastic demand, encourage fee increases and a (likely) reallocation of time to non-surgical activity for which the provider is often overqualified.

As to the wide variations in surgery rates, they do exist and may indeed be attributable to unnecessary surgery, at least in part. A competitive inducement effect on elective (and perhaps unnecessary) surgery, was a principal finding of this study. Nevertheless, the problem of truly unnecessary surgery goes beyond that generated by "idle" surgeons. At bottom, it is an insurance question: "Would I, as a patient, have spent that much on my operation, if any at all, if I had had to pay for it all out-of-pocket?" Often, the answer is no. Unnecessary surgery can derive not only from low operative workloads and conscious surgeon inducement, but also from the moral hazard created by insurance. Our work suggests that while unnecessary surgery is a serious problem too little attention has been given to the fees received for surgery of all kinds, whether unnecessary or not.

In considering the problem, currently popular UCR reimbursement methods do inadvertently set price floors by penalizing physicians who lower their charges. Combined with expanding supplies, the result can be antithetical to price stability if surgeons strive to maintain incomes in the face of slipping workloads. More traditional indemnity policies which set fixed rates for given operations independent of a particular surgeon's charge, take away the direct incentive to raise fees and third-party reimbursements. Regulated fee screens, periodically updated based on CPI data and not stated charges, can accomplish the same thing. Updating still leaves unexplained the inter-area absolute differences in fees, perpetuated by localized reimbursement methods. Instead of a national reimbursement policy designed to reallocate surgeons to needed shortage areas, what we now have appears to exacerbate any already existing distribution problem; to wit, real fees are highest and growing faster in wealthier, surgeon-dense localities.

Solutions to the problem do not come easy-- particularly when expanded entry may worsen rather than improve the situation. If demand cannot be considered as fixed, then fee regulation may be met by increases in discretionary surgery. On the other hand, if surgery itself is controlled, say, through PSRO or utilization review, then inflationary pressures on fees are a probable outcome.

Furthermore, if one or both forms of regulation are used, but only on a portion of a surgeon's caseload (e.g., Medicare/Medicaid), declining participation rates in these public programs are inevitable. Medicare is particularly vulnerable to switching because of the nonparticipation (assignment) option that allows the patient to collect from the government if the surgeon chooses not to accept the allowable fee as payment-in-full. In this instance the patient's out-of-pocket payment, while increased, may not be sufficiently higher to encourage price search. Requiring the surgeon to accept the allowable Medicare rate as direct payment or risk losing elderly patients to those surgeons who will, could be a powerful lever to guarantee participation and, with it, true control over physician charges. Untoward secondary impacts on utilization remain, but may not be that serious for life-threatening or nondiscretionary surgery, if our findings are borne out. An unknown real burden would inevitably fall on the elderly, however, in seeking out surgeons willing to accept direct payment; also, credentials of those performing surgery on a direct payment basis may be lower. Many would argue that this defeats Medicare's goal of improved access and would place an unacceptable burden on the elderly. (Of course, this same argument could already be applied to the Medicaid poor.) Nevertheless, real scarcities of board-certified surgeons are rare, and limited search is likely to be successful in locating a qualified surgeon. As of now little, if any, incentive exists for the elderly, or anyone with insurance, to seek out fee-competitive practitioners. The advantages of "delegating" additional oversight of physicians' fees to millions of Americans may more than outweigh the disadvantages in terms of soaring federal expenditures and higher taxes.

Possibly a more equitable and, in the long-run, more viable approach involves reimbursement schemes which encourage surgeons and their referring colleagues to simultaneously monitor both fees and utilization rates. HMOs are the most obvious examples of this approach although neighborhood clinics, IPAs, and the like could have similar incentive structures depending on how physicians are paid and how patients participate. Medicare and Medicaid reimbursement could be tied in some fashion to HMO utilization, encouraging HMO participation and physician/government sharing of any savings. Without the leverage of the nearly $50 billion in federal health expenditures behind them, HMOs continue to have difficulties making inroads into fee-for-service medicine. In effect federal regulations support the latter through UCR reimbursement techniques, impeding structural change being fostered elsewhere in- and outside government.

II. VARIATIONS IN SURGICAL OPERATIONS: DESCRIPTIVE EVIDENCE

Policy-makers have increasingly become concerned with the high costs attributable to unneccesary utilization, particularly the performance of excessive amounts of surgery. Surgical operations of doubtful marginal utility drive up health care expenditures both through physicians' fees and through hospital charges. At best, such operations may be a misallocation of scarce health resources; at worst, they may endanger the health and well-being of patients who undergo them. Two types of evidence are generally cited as indicative of such surgery:

(1) the rapid growth in the number of operations performed; and

(2) the wide variation in surgery rates across geographic areas.

Increases in Surgery Rates

Per capita surgery rates have beeen rising steadily, over 30 percent from 1968-1977.* A part of this increase can be attributed to improved access (i.e., Medicare and Medicaid) and to the growing proportion of elderly persons in the population. Persons aged 65 years and over undergo surgery at two times the rate of younger age cohorts. Socio-demographic changes and improved health insurance coverage alone cannot account for this phenomenal rise in operations. Surgery rates have been increasing for all age groups, for example, and the rate of increase has actually accelerated somewhat from 1973-1977, thus ruling out excess demand as a possible explanation. (Any unmet demand for surgery prior to the introduction of Medicare-Medicaid should have been realized by 1973.)

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*Excluding obstetric procedures. Despite a declining birth rate, these procedures increased 76 percent, probably as a result of legalized abortion and a greater number of deliveries by Cesarean section.

Table II-1 shows the percent change in per capita utilization for all surgical categories and for certain specific procedures from 1968 to 1977. Increases in surgery rates are clearly not uniform; cardiac surgery has more than doubled over the nine-year period. Ophthalmologic, thoracic, urologic, gynecologic, neurosurgical, and orthopedic procedures also have increasesd considerably. Some types of surgery have actually declined, such as ENT and breast surgery.

How can we account for these large increases in surgery rates? Part of the explanation undoubtedly lies in the development of new medical technology, in the form of both new surgical procedures, (such as coronary bypass grafts), and new diagnostic techniques (e.g., colonoscopy) that permit early surgical intervention for cancer. Improvements in existing technology, such as the bone cement used to correct total joint arthritis, also will tend to raise surgery rates.

Part of the apparent increase in surgery rates may actually reflect a shift in the locus of treatment, from the physicians' office to the hospital. Fractures and certain dental procedures are two notable examples. (The recent development of ambulatory surgical centers in some parts of the country may partly reverse this trend.)

Although diffficult to measure, changing population attitudes also may explain some of the growth in operations, especially for plastic and orthopedic procedures. With an increasing emphasis on physical fitness and an increase in available leisure time, consumers may demand more discretionary corrective procedures, such as knee surgery.

Finally, another possible explanation for rising surgical utilization is inducement by surgeons. The supply of board-certified surgeons alone rose 23 percent from 1969 to 1977 (ACS, 1975).

TABLE II-1:

VARIATIONS IN SURGICAL OPERATIONS OVER TIME AND BY REGION

	Percent Change (1968-1977)	Regional Variation (1977)
All Operations (excluding OB)	+30.9	1.30
Neurosurgery	+69.2	2.10
Laminectomy	*	2.32
Ophthalmology	+46.2	1.40
Lens Extraction	+52.2	1.65
Otorhinolaryngology	-9.4	1.67
Tonsillectomy/Adenoidectomy	-46.1	1.59
Rhinoplasty	+34.1	2.39
Tympanoplasty	*	1.60
Thyroid, etc.	-0.8	1.41
Cardiac	+156.2	1.45
Varicose Veins	-40.0	1.53
Bypass Grafts	*	2.99
Catheterization	*	2.00
Thoracic	+65.7	1.28
Abdominal/Proctological	+5.0	1.25
Inguinal Hernia Repair	-6.0	1.59
Cholecystectomy	+21.4	1.22
Hemmorhoidectomy	-21.2	1.34
Appendectomy	-0.3	1.31
Genito-urinary	+27.0	1.39
Prostatectomy	+30.0	1.42
Breast	-12.6	1.42
Mastectomy	+1.6	1.54
Gynecologic	+38.5	1.33
Hysterectomy	+32.1	1.66
Diagnostic D & C	*	2.06
Orthopedic	+38.2	1.54
Knee Surgery	+146.4	1.72
Prolapsed Disc	+43.1	1.78
Spinal Fusion	+49.1	1.68
Reduction of fracture with fixation	+35.0	1.26
Oral/Dental	+29.6	1.39(oral 4.91(dental)

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* Not Available

Source: NCHS,1973; Unpublished NCHS data for 1968 and 1977.

Geographic Variations in Surgery Rates

While technological advances and a changing age distribution are partly responsible for these disproportionate rates of increase, they do not explain the wide geographic variation observed for almost all surgical procedures. Table II-1 also illustrates this variation by geographic region* in 1977, defined as the ratio of the region with the highest rate to the region with the lowest. Thus, lens extraction is performed 65 percent more often in the West than in the South. Physicians in the remaining two regions also operate more frequently, but their rates are not as high as those in the West.

Similar variations in surgical utilization also have been found across much smaller geographic areas. In Maine, the incidence of discretionary procedures varied significantly across hospital service areas; tonsillectomies, for example, ranged from an age-adjusted rate of 23 per 10,000 population to 122 in a nearby community (Wennberg and Gittelsohn, 1975). Even more striking in some ways, the incidence of appendectomies, a presumably non-elective procedure, was twice as high in some areas as others. Similar inter-area differences in surgery rates have been demonstrated in Kansas (Lewis, 1969), Vermont (Wennberg and Gittelsohn, 1973), and Manitoba (Roos _et al._,1977). How can we account for these variations? There are at least three plausible explanations.

First, there may be differences in the incidence of medical conditions requiring surgery across areas. In the small, and geographically contiguous, areas studied (and cited above), there was no evidence that residents differed in their propensity to develop appendicitis, hemorrhoids, hernias, etc. Roos _et al._ (1977) examined case-specific episodes of tonsillitis and similar diagnoses and found no relationship with the rate of tonsillectomies.

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*Four census regions: Northeast, North Central, South, and West.

Second, there may be differences in access to care across areas. With increasing public and private insurance coverage, financial barriers, especially for surgical services, are probably minimal. Differentials in surgical utilization amoung age and socio-economic groups narrowed considerably from 1963 to 1970, as Medicare and Medicaid increased the demand of elderly and low-income persons for operations (Bombardier et al., 1977). It is also doubtful that the geographical location of surgeons inhibits access in some areas. The SOSSUS report failed to document a shortage of surgeons in any part of the country. In fact, board-certified general surgeons are more evenly distributed across urban and rural areas than any other specialists, including internists and pediatricians (ACS,1975).

Finally, variations in the incidence of surgery may be explained by variations in the surgeons themselves. Practice organization and method of payment may contain (dis)incentives to perform operations. England and Wales, with a nationalized health service, have a surgeon-population ratio only one-half that of the U.S., and perform one-half the number of operations with no discernible detriment in health status (Bunker, 1970). Similarly, studies of prepaid group practices have demonstrated significantly lower rates of surgical utilization compared with traditional fee-for-service practices (Gaus et al., 1976). Pre-paid group practices and health maintenance organizations are still the exception and not the rule in this country, however. The physicians in areas such as Maine and Vermont, like those in the United States generally, are fee-for-service, private practitioners.

Surgeon-population ratios do vary across these geographic areas, however, and they appear to vary positively with the incidence of surgery. Populations with proportionately higher numbers of surgeons tend to have higher rates for most surgical procedures (Bunker, 1970; Lewis, 1969; Wennberg and Gittelsohn, 1973; 1975).* In Vermont, for example, the simple correlation was 0.64 between the number of operations per capita and the number of physicians performing surgery per capita (general surgeons and general practitioners). A causal relationship cannot be inferred from simple correlations, however. Rather than physician-induced shifts in demand, such relationships may reflect the attraction of surgeons to areas with a naturally high demand for surgical services. This methodological problem is compounded by the absence of any time-series analyses. Finally, analyses such as those of Wennberg and Gittelsohn have not explained why one area shows an unusually high rate for one surgical procedure, but an average or even low rate for another. To the extent that some operations are more complex than others, these differences may be explained by variation in the relative mix of surgeons and general practitioners, but only in part.

Do differences in these surgical utilization rates reflect the ability of physicians to generate demand for their services? The econometric evidence will be reviewed in depth in the following chapter.

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*Roos et al. (1977) state they failed to find any relationship between number of physicians and number of tonsillectomies, but do not report any statistical tests. In addition, their physician variable is misspecified; included in their definition are only those physicians who actually performed tonsillectomies.

III PHYSICIAN INDUCEMENT: THEORETICAL BACKGROUND AND LITERATURE REVIEW

Neoclassical and Inducement Models

The positive correlation of utilization rates with physician-population ratios has often been cited as evidence that physicians are able to generate demand for their services. This association can also be explained under traditional economic theory, as a market response to increased competition. In order to better understand the key parameters distinguishing these two explanations, the neoclassical and inducement models will be reviewed below.

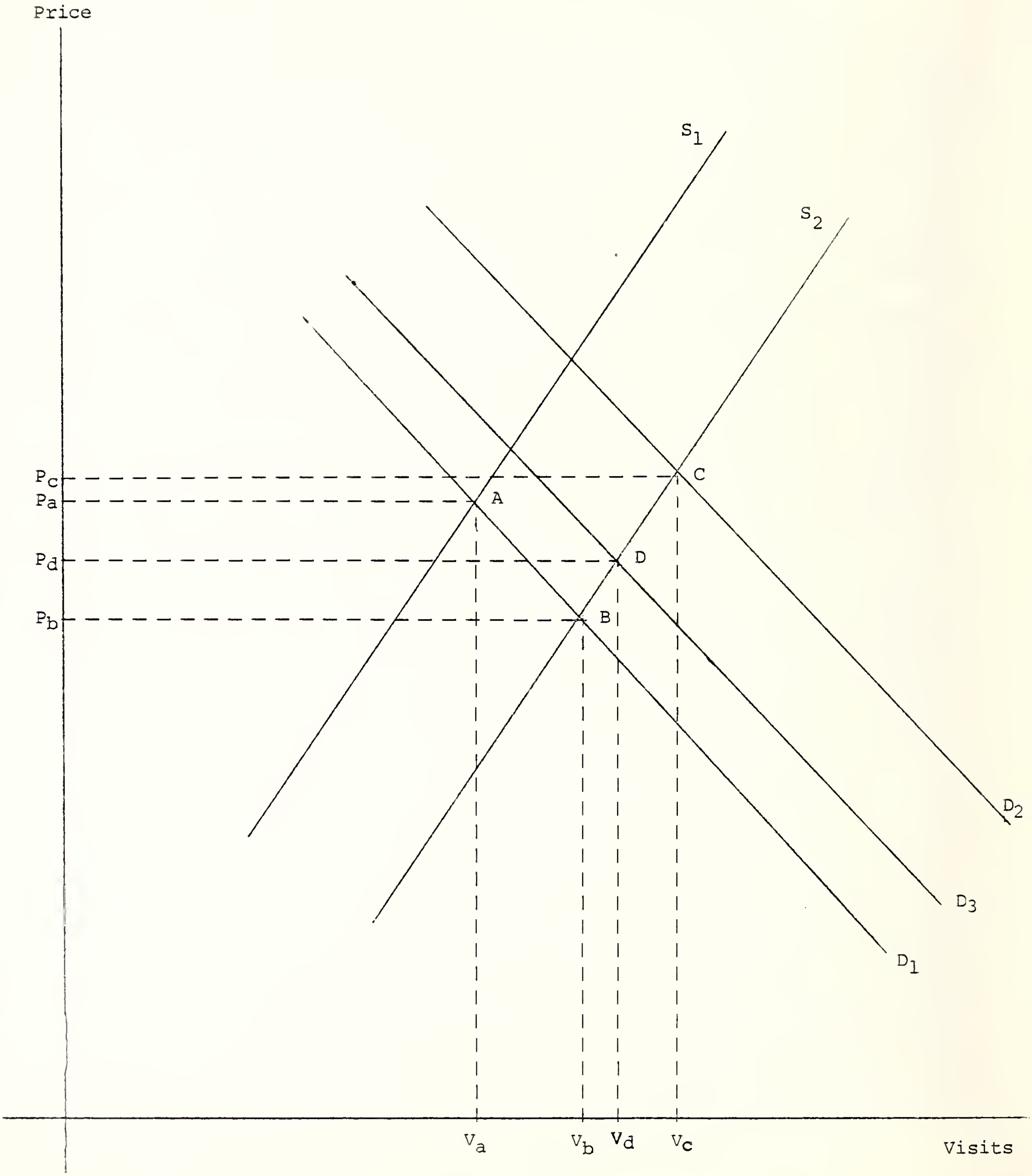
Neoclassical theory argues that the market for physician services acts like any other normally functioning market. Two assumptions are particularly critical. First, the factors determining demand are independent of supply, connected only by price signals. Second, the consumer (or at least the marginal consumer) is able to assess the quality of physician services and to shop for the lowest price. When the supply of physicians increases from S_1 to S_2 (Figure III-1), individual workloads fall, as a fixed patient load is spread among more physicians. Physician incomes consequently fall as well. Physicians respond to this increased competition by lowering their fees from P_a to P_b, and the demand for physician services expands at this new (lower) price. Visits increase from V_a to V_b; note that the original demand curve (D_1) is not altered in any way.

An increase in the number of physicians will also increase utilization by lowering the time price of care. Greater access to physicians presumably reduces travel distances as well as queues in the physician's office.

Inducement theorists argue that two key characteristics of the competitive marketplace, the independence of demand and supply, and consumer sovereignty,

Figure III-1:

IMPACT OF INCREASE IN PHYSICIAN-POPULATION RATIO ON PHYSICIAN FEES AND VISITS



are not present in the medical market. Restrictions on professional advertising and lack of competition limit the consumer's ability to shop for price when seeking physician services. In addition, the technological complexity of medical care makes it difficult for the consumer to evaluate those services. In his role as consumer agent, the physician defines the patient's medical care needs and recommends treatments. At the same time, however, he also provides the services to meet those needs. This dual role of consultant and provider distinguishes the physician from other firms. In particular, it may enable the physician to "shift" patient demand for his services. The large growth in health isurance coverage will reinforce any shift effect, by reducing the net price of care. Financial barriers to more intensive use are nearly eliminated for both patient and physician.

As the physician-population ratio rises, individual workloads fall and so do physician incomes. Under the inducement hypothesis, however, market equilibrium can be obtained not only by adjustments in price, but also by influencing the consumer's perception of need. Physicians may respond to this change by generating greater demand for their services. They may either increase their output or raise their fees, or both. In Figure III-1, the demand curve is shifted rightward, from D_1 to D_2. Here both utilization (from V_a to V_c) and price (from P_a to P_c) have increased, and the ability to induce demand is clear-cut. Individual physician workloads may or may not return to pre-shift levels. If not, a sufficiently large fee increase would still allow physicians to regain previous income levels.

In other instances, however, the physician's discretionary power may be more limited and as seen in Figure III-1, demand is shifted out to D_3; physicians are able to increase visits from V_a to V_d, but not to raise fees as well. Price actually declines from P_a to P_d. Physician incomes (and possibly workloads as well) are likely to fall, but by a smaller amount than in the absence of shifting. Empirically, we can not distinguish this new equilibrium price-quantity nexus (D) from that observed at B. Lower prices and higher utilization rates are consistent with both the inducement and the neoclassical hypotheses. (This dilemma is discussed in more detail below.)

This inducement model explains why physicians shift demand, but it does not explain how this is accomplished or why physicians exercise this ability selectively. These issues are addressed in depth in Chapter IV.

Measurement of Inducement

The ability of physicians to induce demand for their services is generally tested with one or more of the following four dependent variables: 1) utilization (physician services per capita); 2) workload (output per physician); 3) physician fees; and 4) physician incomes. As discussed earlier, however, some effects of an increase in physician supply are consistent with both the inducement and the neoclassical models.

Reinhardt (1978) has compared the impacts of increased supply on the four dependent variables as predicted by both the neoclassical and inducement hypotheses. Comparative statics yielded the predicted effects shown in Table III-1. (This table is adapted directly from Reinhardt.) Increased utilization is compatible with both hypotheses and can be interpreted either as demand shift by physicians, or as a normal market response to lower prices. The impact of increases in the physician-population ratio on physician workloads cannot be signed *a priori* under either model. Similarly, physician incomes are predicted to decline or remain stable in both the inducement and neoclassical models. Only physicians' fees offer a definitive test of the

Table III-1:

PREDICTED DIRECTION OF THE EFFECT OF AN INCREASE IN THE PHYSICIAN-POPULATION RATIO ON UTILIZATION, PHYSICIAN WORKLOAD, PHYSICIANS' FEES, AND INCOME

Dependent Variable		NEOCLASSICAL MODEL Assuming Physicians *Cannot* Induce Demand for Their Services		PROVIDER-INDUCEMENT MODEL Assuming Physicians *Can* Induce Demand for Their Services
1. UTILIZATION (Services per capita)				INCREASE
		INCREASE	*or*	DECREASE*
			or	NO CHANGE*
2. WORKLOAD (Output per MD)		INCREASE		INCREASE
	or	DECREASE	*or*	DECREASE
	or	NO CHANGE	*or*	NO CHANGE
3. PHYSICIANS' FEES				INCREASE
		DECREASE	*or*	DECREASE
			or	NO CHANGE
4. PHYSICIAN INCOME		INCREASE*		INCREASE*
	or	DECREASE	*or*	DECREASE
	or	NO CHANGE	*or*	NO CHANGE

*Reinhardt states these predicted impacts are implausible.

SOURCE: Reinhardt, 1978, p. 168

inducement hypothesis. Neoclassical theory predicts a negative impact of the physician-population ratio on fees, due to increased competition. Declining fees are also compatible with the inducement hypothesis, as shown in Figure III-1. Physicians may succeed in shifting demand, but not sufficiently to return prices to pre-shift levels. Only in an inducement world, however, can physicians succeed either in raising fees or in maintaining them at previous levels. A zero or positive coefficient for the physician-population ratio variable in a fee equation is not compatible with neoclassical theory.

Based on this analysis, fee regressions appear to offer the only conclusive test of inducement. Problems of econometric specification make this test difficult, however, and to date the inducement-neoclassical debate has not been resolved. (The following section discusses the methodologic difficulties encountered in studies of demand shift.) Nevertheless, policymakers are concerned with all estimated impacts of physician demand shifts, and not only that of fees. One policy tool, for example, is the direct regulation of physician fees for public program patients. Lower fees, along with an associated reduction in quantity supplied, must necessarily lead to less total expenditures than before. Or does it? Suppose that physicians use their discretionary power to shift demand so that lower prices are exactly offset by more services, leaving total expenditures unchanged. With a fixed physician supply, workloads have increased, but gross revenues have not changed. Physician incomes would naturally fall, presuming non-physician costs are incurred in providing the extra visits, but from the payor's perspective, nothing has changed. It is quite possible, furthermore, that physicians would exert enough discretionary power that average fees for all patients would rise along with gross expenditures of physician care.

Methodologic Problems

There are at least four other alternative explanations for observed positive correlations between physician supply and utilization (or fees): 1) border-crossing; 2) simultaneity of demand and supply; 3) patient time price; and 4) quality-amenities. All pose problems in the measurement and estimation of demand shifts.

Border-crossing: Since patients may cross geographic boundaries in search of medical care, utilization is often attributed to the location of the provider (hospital or physician) rather than the patient's place of residence. In this instance, supply and utilization will naturally be correlated, and the supply coefficient biased upwards. Population-based reports of physician utilization avoid this problem but only in part. While most SMSA residents may receive their care within the metropolitan area, patients from non-SMSA areas may cross into the SMSA to seek medical care. Demand for physician services thus may be influenced not only by the number of physicians in the non-SMSA area, but also by the supply in the neighboring metropolitan area.

A related problem is the selection of the appropriate geographic area. The use of small areas such as counties are particularly susceptible to problems of border-crossing. The relevant medical market area may cross county, and even state, lines. The use of larger aggregrates avoids the border-crossing problem, but these areas are less adequate proxies for medical markets. This approach also ignores the substantial intrastate and intraregional variations in utilization documented in many studies. The relevant market areas also may vary as a function of the medical service itself. Patients may demand primary care services from local physicians, but travel longer distances to receive more specialized care, such as surgery.

Simultaneity of Demand and Supply: If the demand for physician services and the supply of physicians are simultaneously determined, then the direction of causation may be ambiguous. Physicians tend to be attracted to urban areas with high per capita incomes, i.e., to cities with characteristics expected to raise demand for their services. Thus, rather than inducing demand for their services, physicians may simply locate in those areas where consumer demand is relatively high. Simultaneous equation bias in this instance will lead to overestimates of the impact of the physician-population ratio (MDPOP) variable. The appropriate econometric technique would be to use a predicted, rather than actual, physician supply variable in the regression equations.

Patient Time Price: The price of care includes not only the physician's fee, but also the time costs of travel to, and waiting in, the physician's office. Time costs are generally measured in terms of the patient's real or imputed wage rate. Shorter queues and shorter travel distances (assuming that at least some of the added physicians locate in new areas) will reduce the time price of care and encourage utilization of physician services. At low (or zero) coinsurance rates, time prices will be a relatively large component of total price and hence a more important determinant of utilization. The omission of time price measures from utilization equations will bias the MDPOP coefficient upwards. Unfortunately, empirical data on travel and waiting times are difficult to obtain, and as a result, very few studies have included these variables.

Quality-Amenities: Analysis of variations in physician services (usually visits) per capita assumes that visits are homogeneous procedures nationwide, or at least that product differences do not vary systematically with physician density. In areas with high physician-population ratios, however, fees may be higher because physicians offer a superior product and patients are willing to pay for quality. This allows physicians to maintain a certain income level, even though individual workloads have declined. These "quality-amenities" might include longer office visits spent with the physician, shorter waiting times in the office and in making appointments, telephone consultation with the physician, etc. Waiting in the office, of course, is also a measure of time price. (Increased physician supply is predicted to have the same impact, however, whether waiting time acts as an access or a quality measure.) To the extent that these "quality-amenities" are offered at higher prices and that they increase systematically with physician density, visits are no longer strictly comparable. Policy makers may be unwilling to pay for such amenities, however, and thus choose to ignore these product differences.

Literature Review

Empirical evidence for (and against) the demand inducement hypothesis will be reviewed in detail in four major areas: 1) utilization (services per capita); 2) workload (output per physician); 3) physician fees; and 4) physician income. As shown by Reinhardt (1978) and discussed above, the use of fees as the dependent variable is the only conclusive test for the inducement hypothesis. Estimated impacts on utilization, workload, and incomes resulting from an increase in the physician-population ratio are consistent with both the inducement and the neoclassical hypotheses. Some impacts, however, may be more probable than others; physician income is not expected to rise under either model, for example. For policy purposes, furthermore, these other impacts may be equally important. A positive response of per capita utilization to supply increases may more than offset a decline in fees, thus resulting in higher overall expenditures.

Tables III-2-5 summarize the econometric findings in each of these four areas. All elasticities were calculated at the means. An increase (decrease) in the dependent variable of interest means that the regression coefficient associated with the physician-population ratio was significantly positive (negative) as measured by a t-value $\geq$ 1.96. Estimated parameters forming the basis for the "no change" columns were not significantly different from zero at the five percent level or better. This approach varies from other discussions in the literature which have typically focussed on the size of the elasticity and its sign.

Per Capita Utilization

The majority of studies included here are based on household surveys; since self-reported utilization is attributed to place of residence, rather than provider location, border-crossing is apt to be less of a problem. Nevertheless, the use of large geographic areas (states, and even multi-state regions) as a proxy for market areas in many studies may have resulted in misspecification of both the dependent and the physician-population ratio (MDPOP) variables. Only two studies (Fuchs and Kramer, 1972; Fuchs, 1978) treated physician supply as an endogenous variable. Measures of time price were included only in one (May, 1975).

As shown in Table III-2, no studies report a fall in utilization associated with increases in physician supply. The empirical evidence appears fairly evenly divided between increases in the demand for physician services and no change in utilization. The significance of these findings varies, at least in part, as a function of equation specification and sample definition. Estimated elasticities range widely from 0.03 to 0.80, but appear to concentrate in the 0.24 to 0.40 range. In order to put these results in better perspective, the individual studies are discussed below.

Table III-2:

IMPACT OF INCREASE IN PHYSICIAN-POPULATION RATIO ON UTILIZATION (SERVICES PER CAPITA)

IMPACT STUDY	INCREASE	NO CHANGE	DECREASE
May, 1975	+.137 Office Visits, all resp. +.190 Total Visits, all resp. +.076, Total Visits, pos. resp.	+.006 Office Visits, pos. resp.	
Fuchs, 1978	+.236 → +.329, Operations 1970	+.232 → +.243, Operations 1963	
Holahan, 1975		+.33, AFDC Children (pos. only) +.39, Disabled (pos. only) +.40, AFDC adults (pos. only)	
Davis and Reynolds, 1976	+ *, Low Income Persons +.80, elderly	+ *, Welfare Recipients	
Newhouse and Phelps, 1976	+.03, Total Sample (pos. resp.)	+.17, Heads (pos. resp.)	
Fuchs and Kramer, 1972	+.335 → +.507		
Stano, 1978	+.083, Pos. Resp. and Pos. Dis. Days	+.086, positive resp.	
Held and Manheim, 1980	+.124, expends (GP effect)	+.077, visits (GP effect) -.031 visits (spec. effect)	-.031, expends. (spec. effect)

* Elasticity not reported. Unable to derive from reported data.

In their classic study of physician services, Fuchs and Kramer (1972) estimated four structural equations: per capita utilization, physician location, workload, and per capita insurance benefits. The data base was a 1966 cross-section of 33 states. In order to adjust for differences in specialty mix and the locus of care (hospital versus office), physician visits (the dependent variable in the demand equations) were expressed as "general practitioner outpatient visit equivalents". Per capita utilization was regressed on the average price of physician services (or net price), insurance benefits, physician supply, per capita income, and the supply of hospital beds. The price and insurance variables, and the physician-population ratio, were treated as endogenous explanatory variables. The first-stage physician supply estimates were based on the following variables: predicted average price, predicted physician workload (visits per private physician), per capita income, hospital beds per capita, and number of medical schools in the state.

The predicted physician supply variable was positive and highly significant, with estimated elasticities ranging from +0.34 to +0.51, depending upon the equation specification. This implies that a ten percent increase in the physician-population ratio will increase the quantity of visits demanded by three to five percent. Fuchs and Kramer note that this increase in utilization cannot be attributed to a fall in the money price of care, as average (or net) price was held constant in the demand equation. Given the generally low price elasticities in their equation (approximately -0.2), they also reject reductions in time price as a significant factor. As Sloan and Feldman (1978) have commented, however, this is not necessarily true, if the time price constitutes a large proportion of total price.

May (1975) examined the effect of physician availability on visits, using a 1970 Center for Health Administration Studies (CHAS) household survey of health care utilization and expenditures. Physician-population ratios were defined at the primary sampling unit (PSU) level; a PSU is generally a SMSA or in the case of non-SMSAs, a county or small group of counties. In areas of high physician density, May found that the number of both office visits and total physician visits increased signficantly. Elasticities were quite low, however, probably in part because they were estimated using ordinary least squares regression techniques. The concentration of values for the dependent variable at its lower limit tends to bias coefficients towards zero (39 percent of the sample had no physician visits), and thus Tobit analysis would have been a more appropriate estimation technique. This does not explain, however, why estimated elasticities were considerably lower (and in one case, insignificant) in regressions based on patients who saw a physician at least once. Since the inducement hypothesis is more plausible with respect to follow-up or return visits, Sloan and Feldman (1978) argue that these elasticities are improbable. The first physician visit is more likely to be patient-initiated, either for preventive services or in response to symptoms; the physician, on the other hand, presumably has more discretion in recommending subsequent visits.

May included a second measure of physician supply in his analyses: the ratio of general practitioners to specialists. This variable was positive and significant in all physician visit equations, and elasticities were considerably higher than those for the MDPOP variable. Since May does not provide any theoretical justification for the GP-specialist ratio, it is difficult to interpret it. In part, it probably reflects the availability of office-based physicians generally, as the MDPOP variable was defined as all patient care physicians (clearly an inappropriate specification for the office visit equations). Hospital-based specialists accounted for 26 percent of all patient care physicians nationwide in 1970 (AMA, 1971). The inclusion of hopsital-based physicians may account in part for the large elasticities of the MDPOP variable in the out-patient visit equations, 2.66 for all cases and 2.48 for respondents making at least one visit.

Higher physician-population ratios will also increase access to physician services for more individuals by reducing the time price of care. Omission of time price variables will bias the MDPOP elasticities upwards. While May included measures of travel time and thus controlled for one component of time price, unfortunately, he did not present them in his regressions. Inexplicably, May did not include time spent waiting in the physician's office, although this variable was available in the CHAS survey.

While most utilization studies have analyzed office visit rates, Fuchs (1978) examined the demand for surgical operations. As discussed in detail in Chapter IV, operations have several advantages over visits as a measure of demand shift. In particular, reduced travel and waiting times are unlikely to lower the time price of surgery; the time price of hospitalization and psychic costs associated with the procedure are relatively more important. In the Fuchs study, surgery rates were based on household self-reports from the 1963 and 1970 NCHS Health Interview Surveys. Unfortunately, while the data were collected at the PSU level, they were aggregated into metropolitan and nonmetropolitan areas within eleven census divisions. Regressions were run both across these eleven divisions and the 22 areas. All variables, including surgery rates and surgeon-population ratios, thus were calculated for exceedingly large geographic areas that encompassed multiple medical markets. As a result, both the demand and supply variables may have been misspecified. It is unlikely that any bias was introduced by border-crossing, as Fuchs included an additional supply variable for the nonmetropolitan areas within each census division (the ratio of surgeons in the neighboring metropolitan area to total division population). Rather, the multi-state aggregates will fail to capture the substantial intra-state variations in surgery and physician supply that have been documented in a number of descriptive studies. If these intra-state variations exceed those across census divisions, then Fuchs' estimated impacts of supply on utilization may be biased downwards.

Fuchs treated both surgeon supply and price as endogenous in his demand equations. He found a significant positive relationship between the supply of surgeons and number of operations per capita in 1970, although the impact was reduced when two-stage estimation techniques were used. The estimated elasticities using TSLS ranged from +0.24 to +0.33, depending upon the equation specification. This implies that a ten percent increase in the surgeon-population ratio results in a three percent increase in the number of operations. Discretionary surgical procedures appear to be subject to disproportionately greater shifting; a ten percent increase in the surgeon-population ratio (or about three additional surgeons per 100,000 population) lowered the urgency index by 9.8 percent. The urgency index was a measure of the non-elective nature of eleven frequently performed operations as evaluated by a group of physicians.

The impact of surgeon availability on operations was further illustrated by separate regressions for metropolitan and nonmetropolitan areas. (The 1963 and 1970 samples were combined for these analyses.) Estimated elasticities for the predicted supply variable were twice as high in the metropolitan areas as in the nonmetropolitan areas (+0.53 compared with +0.27), presumably reflecting their respective differences in surgeon density. Given the large surgeon-population increase nationwide over recent years and the markedly even distribution of surgeons across urban and rural areas compared with other specialists, more recent data may show that this differential has narrowed considerably. (Alternatively, metropolitan-nonmetropolitan differences could remain relatively stable, while the elasticities for both areas rise in absolute value.)

In a study of physician services under Medicaid, Holahan (1975) examined variations in expenditures per user as a function of physician-population ratios _inter alia_. Users were defined as Medicaid eligible recipients of APTD and AFDC (both adults and children), who had visited a physician at least once. Since the Medicaid eligible population constitutes only a small proportion of the demand for physician services, physician supply was assumed to be exogenous. State aggregate data were pooled for 1969 and 1970, and regressions run separately for the three population groups. Estimated elasticities for the physician-population ratio were positive and relatively high, ranging from 0.33 and 0.40, but none obtained statistical significance at the five percent level or better. A model of institutionalized price discrimination provides an alternative explanation for these findings. According to this model, the physician faces two markets, a price-setting market in which he faces a downward sloping demand curve and a price-taking market characterized by a horizontal demand curve (i.e., a fixed flat fee schedule). As the physician-population ratio rises, demand per physician falls in the fee-setting market, thus encouraging the supply of services in the price-taking (Medicaid) market.* In the absence of data on total population per capita utilization, Holahan's findings may reflect excess demand of poor persons for physician services in areas of low physician density, rather than demand shifting.

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* See Sloan, Cromwell, and Mitchell (1978) for greater detail on this model.

No adjustments for geographic cost-of-living differences were made in the dependent variable, Medicaid expenditures per user. To the extent that low cost-of-living states also have fewer physicians per capita, the physician-population ratio coefficients may be biased upwards. Instead, average physician charges under Medicare were included as an independent variable to control for interstate variations in medical care prices. This is probably an inadequate adjustment for cost-of-living differences, however, as Medicare charges reflect a number of demand and supply characteristics that are expected to vary across states, including the physician-population ratio.

Davis and Reynolds (1976) also examined utilization rates for selected population groups: public assistance recipients, other low-income persons, and the elderly. Household self-reports from the 1969 Health Interview Survey formed the data base for their study. Physician-population ratios were calculated and merged with individual records in the following manner: by SMSA for persons living in the 22 largest SMSAs, and by SMSA or non-SMSA residence within each of four census regions for all other persons. The latter specification is clearly inappropriate, and border-crossing could produce substantial downward bias in regression coefficients.

Tobit estimation of physician visits for the two low income groups produced positive physician-population ratio coefficients, but only that in the "other low income" (non-welfare) equation was significant. Elasticities were not presented for these equations, and cannot be calculated from the published findings. The supply variable, on the other hand, had a positive and significant relationship with physician visits for the elderly population, with a very high estimated elasticity of 0.80. This is somewhat paradoxical, given the errors in variable problem discussed above. Like Fuchs, Davis and

Reynolds also found that the elasticity of physician utilization with respect to supply was substantially higher in urban than in rural areas, 0.81 compared with 0.54.

Omitted variables may have biased these elasticity estimates upwards, however, as neither money nor time price variables were included in these regressions. As physician-population ratios rise, lower physician fees and reduced travel and waiting times will increase the demand for visits, *ceteris paribus*.

Newhouse and Phelps (1976) examined physician utilization in a 1963 CHAS household-based survey. In order to calculate accurate marginal prices, all individuals with deductibles in their insurance policies and/or whose policies could not be verified were excluded from the analysis. Since the size of the original CHAS sample was not presented, the magnitude of these exclusions is uncertain, but it appears that the sample was reduced by at least 40 percent.

Physician utilization consisted of two components in their study: 1) the use-nonuse of physician services, where the dependent variable is dichotomous; and 2) the number of physician services, conditional upon the respondent having made at least one office visit. Visits were weighted by the mean price for the type of physician seen (GP or specialist) in order to adjust for productivity differences across provider types. Physician prices and insurance were considered endogenous. Equations for the total office visits were not estimated for the entire sample, thus limiting the comparability of these elasticities with those reported by May and Holahan. Unlike other studies, Newhouse and Phelps also included the physician-population ratio both as a linear variable and as a squared term. The latter was intended to capture the reduction in excess demand associated with increased physician supply, and thus hypothesized to have a negative impact on office visits.

The two physician-population ratio variables had the expected signs, positive and negative respectively, but were significant only when the equation was estimated using OLS. The TSLS coefficients were insignificant when tested jointly, although the estimated elasticity was quite small, +0.03. When the visits equation was re-estimated for employed heads of households only, and the squared MDPOP variable dropped, the elasticity for the linear physician-population variable was also positive but still insignificant (+0.17).

Stano (1978) estimated demand equations for physician services, using household responses from the 1971 CHAS survey. The sample was limited to those persons who reported that they had made at least one physician visit. The physician supply variable was defined as total physicians per 1,000 population at the PSU level. This specification, by apparently including non-patient care physicians, is clearly a source of error-in-variables. Non-patient care physicians represented 15 percent of all physicians in 1970; as they are generally engaged in teaching, administration, and research activities, they will be disproportionately located in urban areas.

The physician-population ratio was positive, but not significant, in two stage least squares estimates of physician visits. (Net price was the endogenous variable.) Stano also estimated the demand equation in double-log form and found a significant coefficient associated with the physician supply variable, although its elasticity was quite small (+0.08). For the double-log regressions, however, the sample was halved, as all persons reporting zero disability days were dropped. The resulting sample consisted of relatively sick individuals, i.e., those who reported both positive disability days and physician visits. Although a sicker population might be more sensitive to inducement (i.e., more of their visits are follow-up visits over which the physician presumably has greater discretion), the magnitude of the MDPOP coefficient here was not larger than that for the total sample.

In a very different approach from the above studies, Held and Manheim (1980) analyzed variations in per capita utilization and expenditures for a specific illness: essential hypertension, using 1971-75 claims data from the Quebec health insurance plan. Hypertension was selected because of the considerable physician discretion involved in its treatment. The Canadian health insurance program reimburses physicians on a fixed fee-for-service basis; thus, there is a financial advantage to recommending more visits. The dependent variables were defined as total annual visits per hypertensive patient and total costs per patient year for the treatment of hypertension. (Treatment costs consisted of all payments to physicians by the insurance plan, and included reimbursement for both visits and ancillary services.) Two physician supply variables were specified at the market area (undefined) level: the general practitioner-population ratio, and the specialist-population ratio; both were assumed to be exogenous. Per capita utilization was regressed on these variables: income, individual patient and physician characteristics, family income, and urbanization.

The GP-population parameter had a significant positive impact on per capita expenditures, while the specialist-population ratio had a significant negative impact. Estimated elasticities were quite low, however, +0.12 and -0.03. The two supply variables had similar positive and negative effects (respectively) on utilization, but in neither case were they significant. As specialists tend to concentrate in cities and treat more complex cases, the negative sign for the specialist-population ratio is quite puzzling. (Health status was held constant in the regressions, but it is unclear whether any cost of living adjustment was made.) The authors offer no explanation and in the absence of imformation on the relative geographic distribution of GPs and specialists in Quebec, it is difficult to come up with one.

Physician Workload

Only three studies have been identified that provide econometric evidence on physician workloads. As seen in Table III-3, one study reported no change in physician output associated with an increase in the physician-population ratio. The other two studies found evidence of declining workloads in some equations, but others were insignificant. None of the studies included measures of time price. Only one (Fuchs and Kramer, 1972) considered physician supply to be endogenous.

Evans (1974)* analyzed gross receipts for all British Columbia physicians in 1969 and 1971. Since the Canadian health insurance system reimburses physicians based on a fixed fee schedule, billings are a reasonable proxy for workload. Regional hospital districts were used to define the physician's market area. Sloan and Feldman (1978) have argued convincingly that these areas were misspecified. Evans defined 29 hospital districts in the province, but two of them (Vancouver and nearby Victoria) contained 68 percent of all physicians and 87 percent of all specialists. Thus considerable bias may have been introducted through border-crossing.

Workloads were studied for all physicians and for three subsamples: (1) general practitioners, (2) patient care specialists (i.e. excluding pathologists, radiologists, etc.); and (3) general practitioners and patient

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*More detail on variable construction and characteristics of the 1969 physicians is provided in Evans, Parish, and Sully (1973). This discussion draws upon both articles.

Table III-3:

IMPACT OF INCREASE IN PHYSICIAN-POPULATION RATIO ON WORKLOAD (OUTPUT PER MD)

IMPACT STUDY	INCREASE	NO CHANGE	DECREASE
Feldstein, 1970		+.01	
		+.03	
Evans, 1974		-.087, All MDs, 1971	-.158, All MDs, 1969
		-.125, GPs, 1969	-.274, GPs, 1971
		+.013, Specialists, 1969	-.179, GPs and Specialists, 1969
		+.061, Specialists, 1971	
		-.070, GPs and Specialists, 1971	
Fuchs and Kramer, 1972		-.494	-.662
		-.672	-.665

* Elasticity not reported. Unable to derive from reported data.

care specialists combined. Regressions were run separately for 1969 and 1971. The results were mixed. Physician billings fell significantly with increases in physician density in three equations, while the physician-population coefficient in the other five equations was sometimes positive, sometimes negative, but always insignificant. Evans interprets the small negative elasticities as evidence that physicians are able to induce sufficient demand to protect their workloads from exogenous shifts in supply. Unfortunately, he failed to include any other variables that might be expected to influence demand. (The MDPOP ratios were adjusted for population age differences that might affect utilization of physician services, however.) Although Canadian national health insurance reduced the net price to zero at the time of the study, the province is sufficiently diverse socioeconomically and racially to warrant inclusion of demand variables.

Feldstein (1970) estimated price, demand and supply equations for physicians' services, using 1948-1966 time series data on the United States as a whole. Due to the small sample size, these equations were estimated with ordinary least squares rather than two-stage estimation techniques. Physician output was defined as an index of services provided per private practice physician. The physician-population ratio had a positive, but insignificant, impact on services. Feldstein cites this as partial evidence that physicians enjoy permanent excess demand that allows them to insulate their workloads against supply increases. This excess demand hypothesis has been rejected by a number of economists on the grounds that Feldstein's equations were underidentified (Sloan and Feldman, 1978). Alternatively, as Feldstein himself suggests, the statistical insignificance of the physician-population variable may be attributed to the fact that this ratio changed very little over his time-series. In fact, the relative supply of physicians has remained remarkably stable from World War II up until 1968, with the biggest growth occurring in the 1970's (Dyckman, 1978). Significant impacts of physician-population ratios on workloads (whether positive or negative) thus might only be observed with post-1970 data.

Physician Fees

Econometric analyses of physicians' fees include some of the household-based utilization studies described earlier, and aggregate population studies, as well as studies using the individual physician as the unit of analysis. As shown in Table III-4, the results are extremely mixed. Four studies report that a rise in the physician-population ratio has no discernible impact on fees. One study finds a positive effect, where the dependent variable is defined as the rate of change in fees. The remaining studies report that physician supply has a negative, positive or insignificant effect on prices, depending upon the equation specification. Only three studies compared subgroups of physicians, and there appear to be substantial variations by specialty. Only two studies (Fuchs, 1978; Pauly and Satterthwaite, 1980) treated physician supply as an endogenous variable. No studies included direct measures of travel or waiting time, but Wisniewski *et al.* (1980) employed a price variable adjusted for inter-practice differences in quality, including waiting time.

Sloan (1976) used AMA physician survey data to construct a cross-section time-series for the years 1967-1970, aggregated at the state level. Physician self-reported data were used to specify two price variables: the physician's usual fee for selected procedures, and average revenue per visit. Separate regressions were run for general practitioners, surgeons, and internists. Two

Table III-4:

IMPACT OF INCREASE IN PHYSICIAN-POPULATION RATIO ON PHYSICIAN FEES

IMPACT STUDY	INCREASE	NO CHANGE	DECREASE
Sloan, 1976		-*, GPs, Office Visits +*, Intern. X Revenue	<-.02 GPs Office Visits Hospital Visits -1.0 GPs, $\bar{X}$ Revenue - * Surg. Appen. - * Intern., $\bar{X}$ Revenue
Dyckman, 1978		+.019 -.02, Surg. Fees	
Steinwald and Sloan, 1976	+.260 Intern. Office Visit +.160 OB, Office Visit +.138 OB, Del.	-.063 GP, Hosp. Visit +.033 GP, Appen. -.019 GP, Del. +.051 Surg. Office Vis. +.075 Inter., Hospital Visit +.060 Ped. Off. Visit	-.062 GP, Office Visit -.080 Surg. Appen.
Feldstein, 1970		+.06 +.20	
Fuchs, 1978		+.49, Surg. Fees	
Newhouse and Phelps, 1976	+.50, Heads of Household	+.014, Total Sample	
Hadley and Lee, 1978		-.011, Surgeons +.024, Intern.	-.042, GPs
Redisch, Gabel & Blaxall, 1977	+.69, Surg., X Rev. +.33, Primary Care MDs, X Rev. +.25, Primary Care MDs, Off. Visit	+.07, Surg. Hospital Visits	
Huang & Koropeky, 1973	+*, Rate of Change		
Wisniewski *et al.*, 1980		+*, Quality-adj. visit	
Pauly & Satterthwaite, 1980	+.381, Office Visit (without MDSQ)		-.818, Office Visit (with MDSQ)

* Elasticity not reported. Unable to derive from reported data.

types of physician-population ratio variables were included: (1) the number of physicians in the respondent's own specialty per 10,000 population, and (2) the number of physicians in all other specialties per 10,000 population. Physician fees were hypothesized to be more responsive to within-specialty supply increases. In addition, physicians in other specialties may be referral sources, thus raising demand for the individual respondent's services. (The second MDPOP variable was dropped from the general practitioner equations due to multicollinearity.)

Generally, increases in the within-specialty physician-population ratio variable were found to depress physician fees. Average revenue for the general practitioner, his office visit fee, and his hospital visit fee all declined significantly when the relative supply of GPs rose. The surgeon's usual fee for an appendectomy was negatively affected by the surgeon-population ratio, but positively influenced by the supply of all other physicians. This is as expected, since the all other physician category consists primarily of general practitioners and medical specialist. More than any of the other major specialties, surgeons depend upon their medical colleagues for cases (Shortell, 1972). Individual elasticities are not presented for within-specialty physician-population coefficients, but Sloan reports that they are generally below -0.2. The one exception is general practitioner average revenue, with estimated elasticities around -1.0. Because of the way in which the physician-population ratios were specified, these elasticities are not directly comparable with others reported in Table III-4.

The internist regressions are less conclusive, however. When only the internist-population ratio was included in the equation, internists' average revenue was found to decline significantly. But when the second MDPOP variable was added, the internist supply variable turned positive, albeit insignificant. The other-specialties ratio variable was negative, but also insignificant. Sloan rejects these coefficients as implausible, but it seems likely that the physician-population ratio variables were misspecified. Restricting the ratio to a single specialty is probably inappropriate, as internists do not compete solely with each other, but also with other physicians, especially general practitioners. While the internist may provide a superior product, patients may prefer the lower-priced services of a general practitioner.

Similarly, interpretation of the other-specialties coefficient is ambiguous. On the one hand, this variable includes physicians such as surgeons who may be referral sources for the internist, implying a positive impact on average revenue. On the other hand, it also includes, and is probably dominated by, general practitioners who are (less costly) substitutes for internists; the direction of this effect would clearly be negative. Determination of between-specialty cross-elasticities of demand requires a more careful specification of the substitutability of physicians' services across specialties.

Dyckman (1978) analyzed variations in surgical fees across 124 metropolitan areas in 1976. The dependent variable was specified as the area conversion factor, rather than the fee itself. The conversion factor is the ratio of the average charge for a surgical procedure to the procedure's value on the Relative Value Scale, and thus can be used as a measure of relative fee levels. Physician supply is considered an exogenous variable, although clearly physicians may locate in areas where consumer demand (and hence fees) is high. Dyckman did not include any measure of insurance coverage in his fee equations; to the extent that insurance both raises demand for physician services and reduces sensitivity to price, the MDPOP coefficients may be biased upwards. Once fees were adjusted for geographic cost-of-living differences, however, the physician-population-ratio was insignficant. Estimated elasticities were exceedingly small ($<\pm.02$), suggesting considerable price rigidity in the face of shifts in physician supply. The substitution of a surgeon-population ratio variable for the total physician ratio also proved insignificant.

Physician fee-setting was studied by Steinwald and Sloan (1974), using 1971 AMA mailed questionnaire data. Physician fees were self-reported usual charges for selected procedures deflated by an area price index. Regressions were run separately for GPs, general surgeons, internists, OB-GYNs, and pediatricians. As in Sloan (1976), two measures of the physician-population ratio were included: (1) the within-specialty ratio, and (2) the all other-specialty ratio. Ratios were generally constructed at the county level. Unfortunately, these ratios were not calculated in a consistent manner for all specialties, and some bias may have been introduced as a result of mis-specification. For general practitioners, the two ratios were measured, as previously defined. (Unlike Sloan (1976), both ratio variables were included in the GP equations.) In the case of surgeons and internists, however, the within-specialty ratios were calculated as all surgical and all medical specialists, respectively, per county population. The within-specialty ratio for obstetricians and pediatricians was limited to those two specialties, respectively, but was measured at the state, rather than the county, level. The second MDPOP variable in these equations was total (own and other specialties) physicians per state population. Because these differences in MDPOP calculation imply different effects for parameter estimates in the GP and specialty equations, each set of equations will be discussed in turn.

The within-specialty variable was measured accurately only for general practitioners and, as Steinwald and Sloan themselves point out, these findings are probably more reliable. The GP-population ratio was found to significantly reduce office visit fees for general practitioners, but its impact was insignificant on GP fees for a hospital visit, appendectomy, and obstetric delivery. In all instances, estimated elasticities were very small ($\leq$ 0.06). The all other physicians ratio coefficient was consistently positive, and significant in two equations. These results are puzzling, as general practitioners receive relatively few patients on referral (the hypothesized reason for a positive relationship between fees and the second MDPOP variable).

In the general surgeon equations, increases in the within-specialty ratio had a significant negative impact on appendectomy fees. Increases in the other-specialty ratio raised fees, as the general practitioners and medical specialists who constituted this category presumably made referrals for surgical cases. Neither physician-population ratio variable had a significant effect on office visit fees. Unfortunately, these results are somewhat difficult to interpret, as the within-specialty ratio for general surgeons also included surgical sub-specialists and obstetricians. A large supply of obstetricians in a community would not be expected to influence office visit fees for general surgeons.

A rise in the within-specialty ratio was found to significantly increase office visit fees for internists. The estimated elasticity associated with this MDPOP variable was larger (in absolute value) than those in any of the other fee equations, 0.260. Increases in the other-specialty ratio had a negative impact, a result consistent with Sloan (1976). As discussed earlier, however, this variable was misspecified in the case of internists. Hospital visit fees were not influenced by either MDPOP variable. A somewhat similar problem exists for the internist equations to that of the surgeons; the medical specialist variable used to construct the within-specialty ratio includes pediatricians as well. Internists and pediatricians, however, face markets almost perfectly separated from each another by patient age.

The physician-population variable was consistently positive and significant in the obstetrician equations. Increases in the supply of obstetricians in a state were found to raise obstetrician fees for both office visits and deliveries. Fees were also higher in states with higher total physician-population ratios. The pediatrician-population ratio in a state, however, had no impact on their office visit fees. The supply of total physicians was also insignificant.

The Feldstein (1970) study described earlier also included price equations for physicians' services. Customary physician fee data obtained from the Consumer Price Index were adjusted for the relative utilization rates of the insured and uninsured portions of the population in order to obtain an index of average prices. (The uninsured were assumed to pay less than the customary fee, due to price discrimination.) The physician-population ratio coefficient was never significant. As discussed above, however, there was very little change in this ratio over the 1948-1966 time series.

In his study of surgical operations, Fuchs (1978) constructed a price variable at the census division level from average (surgeon-reported) fees for an initial office visit, follow-up office visit, and follow-up hospital visit. Thus a single price index was used for both metropolitan and non-metropolitan areas within large multi-state regions. As discussed earlier, the use of these large geographic aggregates as medical market areas may have produced a misspecification of both the demand and supply variables, and thus certainly prices as well. Fuchs found a positive impact of surgeon supply on prices, but this relationship was insignificant when two-stage estimation techniques were used. This may have resulted in part from the small number of observations (11) in the price equations.

In their utilization study described earlier, Newhouse and Phelps (1976) also examined prices for physician office visits. The price included not only the physician's charge but also any ancillary services provided as well. Price equations were estimated only for respondents who made at least one physician visit. Individuals reporting free care were excluded. In order to adjust for productivity differences attributable to the provider, the price equation is estimated as a deviation from average price across the sample, based on whether a general practitioner or a specialist was seen. Physician supply was considered exogenous. As before, the physician-population ratio was included in both linear and squared form, and hence fee elasticities are not strictly comparable with others reported in this section. Both specifications of the MDPOP variable were positive, but insignificant. The price equation was also estimated for employed heads of households, with the squared MDPOP term dropped. Increases in physician supply resulted in significantly higher fees, with an estimated elasticity of +0.5. These results were obtained, however, on a group of household heads that represented only 21.8 percent of the original CHAS sample of heads. This is a drastic reduction in sample size, however reasonable the exclusion criteria, and it is unlikely that either respondent characteristics or prices are still representative.

Hadley and Lee (1978) examined physicians' price and output decisions, using all claims paid by California Medicare and Medicaid to a cohort of physicians from 1972-1975. The cohort consisted of general practitioners, general surgeons, and internists in solo practice in northern California. The dependent fee variable was defined as the physician's billed charge, per California Relative Value Scale (CRVS) unit, in order to adjust for casemix and service intensity variations across physicians and over time. Two physician supply variables were constructed: (1) physicians in the same specialty per capita; and (2) physicians in all other patient care specialties per capita. Separate equations were estimated for each specialty, using ordinary least squares.

The GP-population ratio had a significant negative impact on GP fees, although the associated elasticity was quite small, -0.04.* Unlike Steinwald and Sloan, the other physician ratio also had the expected negative sign, and was significant. The supply variables in the internist and surgeon equations were uniformly insignificant. Specialists appear better able to maintain existing price levels, when the physician-population ratio increases. The other-specialty ratio in these two equations was probably misspecified, however, for the same reasons described earlier regarding the Sloan and Steinwald-Sloan studies. This variable incorporates both specialties expected to compete with the reference physician and specialties that serve as referral sources.

Redisch, Gabel and Blaxall (1977) analyzed physician fees, using a national survey of private practice, office-based physicians. Survey physicians were divided into two samples: (1) primary care physicians (general practitioners, internists, and pediatricians); and (2) surgical specialists (general surgeons and obstetrician-gynecologists). Two fee variables were constructed, based on physician self-reports: (1) usual fee for follow-up office visit for primary care physicians, and usual hospital follow-up visit fee for surgical specialists; and (2) average revenue (the physician's gross income divided by total visits). The latter variable contains considerable measurement error, as physicians in this survey have been found to overestimate their work effort (Sloan, Cromwell, and Mitchell, 1978). The price variables were not adjusted for geographic cost-of-living differences. Physician supply was assumed to be exogenous to physician fees; and the MDPOP variables were merged with individual physician records at the PSU level.

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*The elasticities presented here were calculated using means for Medicaid participants, as Hadley and Lee do not present means for the sample as a whole. Elasticities were also computed for physicians not participating in Medicaid and were found to be almost identical to those shown here.

Reduced form equations were estimated separately for the two physician samples. The primary care physician supply coefficient was significant and positive in both price equations. Surgeon density had a positive, but insignificant, impact on hospital visit fees. The estimated elasticity associated with average revenue for surgeons and OB-GYNs was significant and quite large (+0.69). These elasticities are probably upwardly biased, however, due to incomplete equation specification and errors-in-variables. The only exogenous demand variables included were the percent of the physician's practice with no insurance, the percent with high (undefined) family incomes, and percent black. These variables were all based on the physician's self-report, and they undoubtedly contain considerable measurement error. They are also probably endogenous to the individual physician's pricing decision. More appropriate demand variables would have been per capita income and health insurance coverage, defined for the physician's PSU.

Huang and Koropecky (1973) examined variations in the rate of change in Medicare physicians' fees from 1967-1969, based on a five percent sample of Medicare enrollees, grouped by state. Only those states in which a single Medicare carrier was responsible for the entire state, were included in the analysis. This limited the sample to 35, and excluded such states as New York and California. The dependent variable was defined as the total growth rate in the average actual charges of physicians participating in the Medicare program. Charges were not adjusted for geographic cost of living differences. The physician supply variable consisted only of general practitioners, for reasons not specified in the report. The GP-population ratio was consistently significant and positive; Medicare fees appeared to increase more quickly in areas of high physician density. Unfortunately, elasticities could not be calculated from the data presented, but the magnitude of the effect appears relatively small.

With the exception of Newhouse and Phelps, who adjusted prices for productivity differences attributable to specialty, all of the preceding studies assumed that the quality of physician services does not vary systematically with MDPOP. If physicians in high MDPOP areas offer higher quality services and patients are willing to pay for quality, however, then fees may also be higher. Using the 1975 Mathematica Telephone Resurvey of office-based GPs, pediatricians, and internists, Wisniewski et al. (1980) developed a quality-adjusted price index. A hedonic function was estimated, in which the price of a routine office visit was regressed on a set of physician and practice variables believed to influence quality. Visit prices were based on sample physician reports of their usual charge, and were deflated for geographic cost-of-living differences. Measures of quality included both practice characteristics (visit length, examination rooms available, waiting time, appointment delays, non-reimbursed telephone consultations, the availability of weekend hours, and labor inputs) and physician attributes (specialty, sex, experience, FMG status, and board certification). Due to possible measurement error in some characteristics of group practices, the hedonic analysis was limited to solo physicians. Practice and physician characteristics generally had the predicted impacts on price, with some noteworthy exceptions. The appointment delay and waiting time variables were significant and positive.

Based on this hedonic regression, office visit prices were adjusted for quality differences, and the adjusted prices were regressed on a set of market characteristics. Physician supply was treated as exogenous. Most of the variation in quality-adjusted prices was explained by per capita income and geographic location. The MDPOP coefficient was positive, but insignificant. Although these findings suggest that a large component of physician fee variation may be due to quality differences, the validity of the adjusted price variable is questionable.* First, average prices based on survey physician self-reports were not highly correlated with Medicare prevailing charges for the same geographic area, suggesting that the former may not be reliable measures of market prices. In addition, the R-square associated with the hedonic price function was quite low, 0.26.

Pauly and Satterthwaite (1980) developed an alternative model to explain physician fee variation: the "increasing monopoly" theory. They argue that as the absolute (not only the relative) number of physicians increases, there is a corresponding increase in consumer ignorance. Consumers are less able to

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*It must be noted that these findings are preliminary and the authors plan to extend their analyses. Among other things, they plan to address the problems we note here.

"compare notes" with each other on the price and quality of physician services; as a result, fees rise. Consumer ignorance was proxied by the number of physicians per square mile, and measures of "social instability", such as female-headed households and population turn-over. Pauly and Satterthwaite estimated price equations for 92 SMSAs. For reasons not specified, they employed data based on very different points in time. The dependent variable was 1973 self-reported fees for a routine office visit, while the key independent variables, MDPOP and physicians per square mile, were constructed from 1969 data. The fee data, furthermore, were based on the original Mathematica telephone survey, and thus are subject to the same problems of validity encountered by Wisniewski et al. Two-stage least squares techniques were employed, with both physician variables treated as endogenous.

The MDPOP and the physicians per square mile (MDSQ) coefficients were significant and with the opposite signs (negative and positive, respectively). Although Pauly and Satterthwaite cite this as confirmation of their theory, the two physician variables are undoubtedly highly colinear and resulting parameter estimates are probably very imprecise. In fact, when the physicians per square mile variable was dropped, the MDPOP coefficient turns positive and significant. Unfortunately, the other information variables were also omitted, and the two equations are not directly comparable.

Physician Incomes

Physician income can be defined either as total earnings or as an hourly (or weekly) wage rate, a specification that adjusts for work effort. Of the four studies shown in Table III-5, two (Sloan, 1975 and Kehrer, 1976) included adjustments for hours worked; both reported a significant decline in earnings associated with increases in physician supply.

Table III-5:

IMPACT OF INCREASE IN PHYSICIAN-POPULATION RATIO ON PHYSICIAN INCOME

IMPACT STUDY	INCREASE	NO CHANGE	DECREASE
Kehrer, 1976			-.085 Males -.162 Females
Sloan, 1975		-.249, Hourly Wage, 1960	-.205, Hourly Wage, 1970 -.352, Weekly Wage, 1960 -.236, Weekly Wage, 1970
Benham, Maurizi, and Reder, 1968		-.13, 1928 -.70, 1941 -.12, 1960 -.24, 1963	-.33, 1949
Redisch, Gabel, and Blaxall, 1977		*, Surgeons -.07, Primary Care MDs	

* Elasticity not reported. Unable to derive from reported data.

Kehrer (1976) analyzed self-reported 1972 income data for men and women physicians from an AMA survey. The income variable was defined as the net hourly wage; the physician-population ratio was calculated for the respondent's county. Increased physician supply was found to significantly reduce hourly earnings for both men and women physicians. Increased competition appears to affect women physicians disproportionately more than men physicians, however; the estimated elasticity of income with respect to MDPOP was twice as large for women physicians as for men (-0.162, as compared with -0.085).

Sloan (1975) estimated hourly and weekly wage equations for physicians, based on the 1960 and 1970 public use sample of the census. All income data were thus self-reported. A rise in the physician-population ratio (calculated for the respondent's state) significantly reduced weekly earnings in both 1960 and 1970, and hourly earnings in 1970. Estimated elasticities were somewhat lower in 1970 than in 1960, even though the physician-population ratio had begun to increase towards the end of this decade. Sloan's elasticity of net hourly income for 1970 is somewhat larger than that obtained by Kehrer for male physicians in 1972 (-0.205, compared with -0.085). However, the different sampling strategies employed in these two studies preclude any further comparisons.

Benham, Maurizi, and Reder (1968) analyzed average physician incomes, using selected state aggregate data for the years 1928, 1941, 1949, 1960, and 1963. Physician income data were obtained from a variety of secondary sources and were unadjusted for work effort. The income equations also were incompletely specified; insurance coverage was not included for example, an omission that may explain the generally smaller R^2s obtained with their more recent (1960, 1963) cross-sections. The elasticity of physician income with respect to the physician-population ratio was always negative, but significant only in 1949.

Redisch, Gabel, and Blaxall (1977) analyzed variations in physician net income based on the physician survey described earlier. The dependent variable was constructed from physician self-reports. The physician supply variable was not significant in either the primary care physician or the surgical specialist equations. Although the authors cite this as evidence that physicians are able to insulate their incomes from supply shifts, their equations are incompletely specified, as discussed earlier. Failure to adjust for work effort and geographic cost of living differences also will bias the MDPOP coefficient towards zero.

Patient Time Price and Quality-Amenities

Neoclassical theory predicts that increased physician supply will lead to lower time prices, as well as lower fees. Lower time prices, as measured by reduced travel and waiting times, will in turn result in higher utilization. Under conditions of physician density, physicians may also offer certain amenities for which patients are willing to pay higher fees, viz. shorter waiting times and longer office visits. The econometric evidence in this area is limited to four studies and is reviewed below. Estimated elasticities from these studies are shown in Table III-6.

Sloan and Lorant (1977) analyzed variations in waiting time for the five primary care specialties. Waiting time was defined as the average number of minutes spent waiting in the physician's office, based on physician self-reports from the 1973 AMA survey. Although physicians might be expected

Table III-6:

IMPACT OF INCREASE IN PHYSICIAN-POPULATION RATIO ON TIME PRICE AND QUALITY AMENITIES

IMPACT STUDY	INCREASE	NO CHANGE	DECREASE
Sloan and Lorant, 1977		-.043 Waiting Time, All MDs -.087 Waiting Time, Surgeons	-.070 Waiting Time, All MDs -.076 Waiting Time, All MDs -.102 Waiting Time, Surgeons
Sloan, 1977		*Waiting Time *Travel Time	
Sloan and Lorant, 1976	+.106 Length of Visit (MD Time) +.061 Length of Visit (All Time)		
Wisniewski et al., 1980	+ *, length of visit + *, telephone consultation	- *, weekend hours	- *, waiting time - *, appointment delay

* Elasticity not reported. Unable to derive from reported data.

to bias these estimates downwards, the authors report that these waiting times are quite similar to responses obtained from a household interview survey. Increased physician supply was found to have a significant negative impact on waiting times on average, and they appeared somewhat more responsive to changes in the physician-population ratio. Estimated elasticities were generally quite low, (≤ -0.10), however, and imply that extremely large increases in physician supply would produce quite modest reductions in waiting time. (An increase from 0.25 physicians per 1,000 county population to 3.75 would reduce waiting times from 24.7 minutes to 20.1 minutes. The average physician-population ratio in the sample was 1.61 per 1,000.)

Sloan (1977) examined patient reports of waiting and travel time from the 1969 NCHS Health Interview Survey. Physician-population ratios were merged at the PSU level and observations then aggregated into 60 "communities": (1) the 22 largest SMSAs divided into central city and suburban areas, (2) four smaller SMSAs divided into the same two areas, and (3) the remaining PSUs grouped by farm or non-farm area within each of four census regions. Border-crossing is almost certainly a problem for these last eight communities, and possibly for some of the others as well.

Travel time and waiting time regressions were run separately for two subsamples: employed persons aged 18-64 years, and nonemployed women 18-64 years old. The physician-population ratio was not a significant predictor in any of the equations.

Using the same data base as their waiting time study (1973 AMA survey), Sloan and Lorant (1976) found significantly longer office visits associated with increased physician supply. The sample was limited to general practitioners, internists, pediatricians, and obstetrician-gynecologists. Two dependent variables were constructed, based on physician self-reports: (1) mean physician time spent per office visit, in minutes; and (2) mean time spent by the physician and his aides per office visit. Although physician estimates were probably biased upwards, there is no reason to expect that they vary systematically and thus might affect regression coefficients. The physician-population ratio coefficient was positive and significant in both equations. Estimated elasticities were very low, however (< +0.11), suggesting that substantial increases in physician supply would result in only slightly longer visits.

Using the data base described earlier, Wisniewski et al. (1980) also analyzed the variation in five amenity variables: delay in making an appointment (days), waiting time in the office, length of visit, telephone consultations per office visit, and the availability of weekend hours. Reduced-form equations were estimated separately for each variable, with the physician as the unit of analysis. The MDPOP coefficient was significant in the predicted directions in four of the five equations. In areas of high physician density, physicians offered longer visits, shorter appointment delays, shorter waiting times, and more telephone consultations. The availability of weekend hours was associated with lower physician-population ratios, contrary to prediction, but was insignificant. The use of OLS with this binary dependent variable (available/not available), however, undoubtedly biased significance-testing.

IV CONCEPTUAL MODEL OF THE DEMAND FOR OPERATIONS AND THE SUPPLY OF SURGEONS

The Use of Surgical Operations to Measure Induced Demand

Surgical operations will be used to test the ability of physicians to shift demand for their services in response to changes in the physician-population ratio. Operations have several advantages over other measures of physician output. First, operations are discrete procedures that are homogenous with respect to definition and duration across the country. Unlike office visits which may vary in length and/or number of ancillary services provided, a hysterectomy in New York is the same procedure as a hysterectomy in New Mexico.

Second, it is unlikely that a shortage of surgeons has constrained the demand for operations. Under conditions of "excess demand", we would expect to observe a (right-ward) shift in demand associated with any increase in surgeon supply. All evidence suggests the reverse, however; workloads are generally low for surgeons and they state that they would be willing to provide more operations at prevailing market prices (Hughes, *et al.*, 1972). In addition, general surgeons are more evenly distributed across geographic areas than any other specialists (ACS, 1975).

Third, reduced search and travel costs associated with high physician density are probably not an important factor in the increased demand for operations. As Fuchs (1978) has noted, the psychic costs of surgery and the time costs of hospitalization are high relative to these other time costs. (The lengths of hospital stay and convalescence also are presumably independent of any shifts in the physician-population ratio.)

Fourth, widespread insurance coverage of inpatient services has reduced the net price of surgery to zero or near zero. The absence of accurate price data for all years in the time series is likely to be less of a problem with surgical procedures than it would be with physician office visits. Over three-fourths of the U.S. population (79.9%) had private insurance for surgical expenses in 1975, while the majority of the remainder were covered under Medicare and Medicaid (Dyckman, 1978). Health insurance coverage for ambulatory physician visits on the other hand, is generally less extensive and also more likely to include deductible and coinsurance provisions.

Despite these advantages, the use of surgical procedures has several drawbacks for testing demand shifts. First, border-crossing, particularly from nonmetropolitan areas into SMSAs, may be more common for operations than for office visits. Prospective surgery patients are probably more willing to travel long distances in order to obtain access to more specialized physicians and facilities and to ensure a higher quality of care. (Increased travel costs will still be a relatively small proportion of the total time price for surgery, however.) Failure to adjust for border-crossing will result in a misspecification of the relevant market area for operations and an upward bias in the effect of the surgeon-population ratio.

Second, surgeons supply ambulatory services as well as operations, and may find it easier to shift demand for office visits than for surgical procedures. Unlike office visits, operations are subject to some external controls, such as hospital tissue and utilization review committees. The physician may have greater discretionary influence over pre-and postoperative visits. Reinhardt (1978) furthermore, has suggested that ancillary services, such as laboratory tests, may be most susceptible to demand-shifting. Prescription and production of these services can yield high net revenues without requiring a large input of the physician's own time. The use of operations thus may be a conservative test of inducement.

The Demand for Surgical Operations

Rates of surgical utilization are not technologically determined, varying solely as a function of physician assessment of health care needs. If so, we would observe a vertical, rather than downward sloping, demand curve. Instead, surgery rates are jointly determined by price, and other demand and supply characteristics. Specifically, the demand for surgical operations is a function of sociodemographic characteristics, health status, ability to pay, the price of surgery (including time prices), the availability and prices of substitute sources for care, and the extent of inducement by surgeons.

Sociodemographic Characteristics

Sociodemographic characteristics of the patient population influencing surgical utilization include age, sex, race, and education.

Age: Surgical utilization increases in a linear fashion with age, largely as a result of declining health status over time. NCHS Hospital Discharge data for 1977 show surgery rates for elderly persons to be 33 percent higher than those of persons aged 45-64 years, 16,594 per 100,000 population compared with 12,451 (NCHS,1979). Children (under 15 years) and young adults experience the least surgical utilization, with rates of 4,068 and 9,002 respectively.

The mortality risks associated with surgery also increase with age, as elderly persons are less able to tolerate physical trauma. Thus, we would expect to observe lower rates for discretionary surgical procedures on the elderly, e.g., cataract removal and prostatectomy. Others, however, are performed less frequently on the aged, such as varicose vein excision and spinal fusion. Bombardier et al. (1977), on the other hand, found that persons aged 65 and over were significantly less likely to undergo operations rated as unnecessary by a sample of physicians. The necessity index was constructed only for eleven selected procedures, however, and thus comparisons across age or other subgroups will reflect in part the relative frequency of these operations.

Sex: Women demand more surgery than men at all ages, even when obstetric procedures are excluded (NCHS, 1979). Women also have higher utilization rates for all types of health care, including physician visits and dental care (Anderson and Andersen, 1972). As there is no reason to believe women are generally sicker, these differences in behavior have been attributed to differential socialization, i.e., men may be less likely to admit weakness and seek help (Mechanic, 1972).

Race: Whites experience significantly higher rates of surgical utilization than do non-whites, but the effect of race disappears when controlled for income (Bombardier et al., 1977).

Education: Education also strongly influences the demand for surgery, but the relationship is not straightforward. More highly educated persons are generally believed to utilize more health care services of all types, in part because they are more knowledgeable about the value of medical care. Alternatively, as Grossman (1972) has suggested, educated persons may be more efficient in combining inputs to achieve health, and hence require fewer medical services. Better educated persons are consistently healthier, whether health status is measured by patient self-reports or by relatively more objective measurements such as mortality rates. The relationship of education with utilization is more ambiguous, however, as education is also closely correlated with income, which is hypothesized to have both positive and negative effects on surgery rates. (This issue will be described in detail below.) Data from 1970 indicate that surgery rates are higher when the head of household has nine to 14 years of schooling, compared with those with either less or more education. Bombardier _et al_. (1977) suggest that the higher education groups (more than 14 years) may have better ambulatory insurance coverage that facilitates non-surgical treatment.

If education is a good proxy for consumer knowledge of health care, then the ability of physicians to shift demand would vary inversely with level of education. Highly educated persons would be less sensitive to inducement, and experience lower utilization rates, _ceteris paribus_. Fuchs (1978) estimated separate demand equations by education class, and found some support for this hypothesis; the predicted surgeon supply coefficient was largest for the low education class and smallest for the high-education class, but the coefficients were not significantly different.

Health Status

Health status and income are positively correlated, and failure to adjust for the former may lead to biased parameter estimates. When unadjusted for health status, medical care utilization by income classes is U-shaped, with mid-income persons using the fewest services (Davis and Reynolds, 1976). High utilization by low income persons suggests that the poor may need more services due to poor health. Once adjusted for health status, however, we observe the expected linear relationship between utilization and income.

Ability to Pay

Patients' ability to pay for surgery also influences the demand for operations. Ability to pay includes income and health insurance coverage. By reducing the price of care, health insurance coverage is hypothesized to raise surgery rates. Income, however, has offsetting effects on utilization and its net impact cannot be determined *a priori*.

Income: The impact of income on surgery is difficult to disentangle, as income affects both health status and medical care utilization. High income allows individuals to purchase more of all types of services, including health care. We might call this the "pure" effect of income on demand for medical care. Higher utilization presumably leads to improved health status, which would reduce utilization rates later on. High income, furthermore, is also associated with other factors shown to raise health, e.g., education and increased consumption of other goods such as good housing. Grossman (1972) found that income did not significantly affect health status, but had a negative impact on utilization. One possible explanation is that high incomes may also lead to increased consumption of goods which reduce health, e.g., rich food and liquor.

It is important to distinguish between earned and unearned income. The hypothesized effect of unearned income on utilization is unambiguously positive, because there are no opportunity costs due to lost income. Earned income, as measured by wage rates, may have two offsetting effects. On the one hand, high wage rates make health more valuable and induce the individual to purchase more surgical services. They also are associated with better insurance coverage, which lowers the net price of care and thus raises demand. High wage incomes, on the other hand, raise the time cost of care, thereby reducing utilization. The time price of surgery is especially high, as described in detail below. The net impact of earned income on surgery rates thus cannot be determined *a priori*. Grossman found that wage rates have a positive impact on both health and use. Acton (1975) also reported a positive relationship between the wage rate and physician visits, but a negative elasticity of demand for more time-intensive hospital services. As money prices are reduced through increased insurance coverage, the demand for medical care is likely to become more sensitive to time prices, as the time price constitutes a larger proportion of total price.

Health Insurance Coverage: As of 1976, approximately 75 percent of the U.S. population was currently enrolled under private insurance plans for hospital care and surgeons' services (Carol, 1978). Medicare and/or Medicaid provide coverage for most of the rest of the population. Health insurance coverage does not necessarily reduce the net price to zero, however, as most insurance policies require that the patient pay some combination of deductibles and coinsurance. Under Medicare Part B, for example, the patient is responsible for paying 20 percent of the physician's fee, plus the deductible of $60 per calendar year (if not previously satisfied). In addition, all patients bear some portion of the hospital costs. Thus, despite the widespread availability of health insurance, income may be a more important predictor of surgical utilization than insurance coverage at the margin. The net price of surgery, including time price, is discussed in detail in the following section.

Price of Surgery

The gross (total) price of surgery can be disaggregated into the following three components:

(1) The price of hospitalization -- the hospital per diem charge times length of stay, plus hospital charges for ancillary services;

(2) The price of surgical services -- the surgeon's fee for performing the procedure, plus any additional fees for pre- or post-operative visits; and

(3) The time price -- the opportunity costs of the patient's time including the length of hospital stay, convalescence, and pre- and post-operative physician visits.

The first two prices will be reduced to the extent of the patient's health insurance coverage. Coinsurance rates, both under Medicare and private health insurance, generally differ for hospital care and for physicians' services. Patients will generally also face separate deductibles for hospital care and surgical services. Since in the case of surgery, these deductibles are exceeded almost immediately, demand for surgery is assumed to be more responsive to the coinsurance rate.

The net price (NP) of surgery can be formulated as follows:

$$NP = AP_{HD} \cdot \Sigma\, HD + AP_S + AP_{OV} \cdot \Sigma\, OV + W_D \cdot \Sigma\, HD + W_H \cdot (\Sigma\, OV + T_{TW})$$

where AP = average price paid out-of-pocket, i.e., the co-insurance rate

HD = hospital day

S = surgical fee

OV = office visit

W_D = time price (per day)

W_H = time price (per hour)

T_{TW} = travel and waiting time

Each of the three major components of price will be discussed in turn, together with a discussion of coinsurance rates (where appropriate).

Price of Hospitalization: Besides paying the surgeon's bill, the patient is responsible for the "room and board" expenses associated with his inpatient stay (i.e., the hospital's per diem charge), plus additional charges for ancillary services. The price of hospitalization is likely to constitute a large proportion of the total money price of surgery, especially given a mean length of stay of 7.8 days (NCHS, 1976). The price of hospital care is equal to the product of the per diem charge and length of stay, plus ancillary charges. Where hospital charges are low, the demand for surgery is expected to be higher.

The effect of hospital insurance has been to reduce the price of hospitalization. Over three-quarters of the U.S. population (76.8%) currently have private insurance coverage for hospital care (Carol, 1978). The majority of the remainder are covered by Medicare and/or Medicaid. The net price of a hospital day faced by the patient is determined by the coinsurance rate. Elasticities for coinsurance with respect to hospital utilization have been consistently negative. Patients are more likely both to be admitted to the hospital (Newhouse and Phelps, 1976) and once admitted, to stay there longer (Phelps, 1976), when coinsurance rates are relatively low.

The total price of hospitalization depends not only on the coinsurance rate, but also on the hospital length of stay. While coinsurance rates do not vary as a function of the type of admission, surgical patients may experience longer hospital stays and hence incur higher total costs. Lengths of stay do not vary substantially for surgical and non-surgical admissions, however. Persons with surgery remain in the hospital only 0.3 days longer on average than those without surgery. Elderly patients undergoing surgery, on the other hand, do stay approximately three days longer in the hospital, probably because of their more fragile health status rather than a different mix of operations. This is unlikely to significantly raise the costs of hospitalization for the aged, as the coinsurance rate under Medicare Part A is zero for the first 60 days of care.

The Price of Surgical Services: The gross price of surgical services includes the surgeon's fee, plus any fees for pre-and post-operative care, including both office and hospital visits. Charges for post-operative visits have traditionally been included in the basic surgical fee. The surgical weights associated with the California Relative Value Scale, for example, explicitly include the normal uncomplicated follow-up care required for specific procedures. Thus, the surgical fee for inguinal hernia repair would include physician services for 45 post-operative days. Recent anecdotal evidence indicates that some surgeons have begun charging separately for these services, thereby raising total surgical prices (Owens, 1974).

Health insurance coverage for physician hospital services, including surgery, is more extensive than coverage for ambulatory physician visits. Over three-quarters of the U.S. population under 65 are covered by private health insurance for surgical services (78.3%) and in-hospital visits (76.3%) as compared with only 62.2 percent for office and home visits (Carol, 1978). Many of the remaining persons are eligible to receive care under Medicaid. Almost all individuals 65 years of age and older receive Medicare, which will reimburse physician services without regard to the site of care. Approximately one-half of the elderly also have private health insurance to cover the Medicare Part B deductible and coinsurance (Carol, 1978)*.

The net price of surgical services is determined by the coinsurance rate. Estimated price elasticities for physician services have generally been negative, as expected (Newhouse and Phelps, 1976). Demand equations for physician services have specified either office visits or total visits as the dependent variable; price elasticities for surgical services have never been estimated to our knowledge.** We would hypothesize, however, that surgical utilization also responds positively to a reduction in net price.

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*Percent of elderly population covered by private insurance for: surgical services (55.6%), in-hospital visits (43.4%), and office visits (24.1%).

**Fuchs (1978) attempted to include a predicted price variable in his surgery demand equations, but was unsuccessful.

Time Prices: As the out-of-pocket costs of hospitalization and surgical services are reduced through health insurance coverage, the time costs of surgery become a larger proportion of total costs. The time costs of surgery include the length of hospital stay, time spent in convalescence, and the time associated with pre- and post-operative office visits, including travel and waiting time. Because of the hospitalization involved, total time costs for surgery are high relative to those for other medical services. Persons with a high time price (i.e., high wage rate) demand fewer hospital admissions (Acton, 1975) and presumably less surgery as well. However, high wage income will also make health more valuable and may encourage surgical treatment of certain conditions that reduce productivity. Thus the time price of surgery should be net of work loss or restricted activity days that would have been incurred in the absence of surgery.

The demand for elective operations will be relatively more responsive to changes in time price. Individuals with a high wage rate thus should have lower utilization rates for discretionary procedures. Individual perceptions of what constitutes elective versus non-elective surgery may vary systematically with wage rates, or simply with employment status. Both the businessman and truck driver, for example, are less likely to view lens excision (for cataracts) as a discretionary procedure than are the housewife and retired person.

Substitute Sources of Care

Where the price of surgery is high, patients will demand more non-surgical care. The extent to which patients can substitute alternative types of care for surgery will depend on the relative supply of medical specialists and general practitioners (GPs). Where the supply of pediatricians is high, for example, relative to surgeons, we would expect tonsillitis to be treated with antibiotics and bed rest, rather than by tonsillectomy. The extent of substitution may be attenuated, however, by the bias of most health insurance plans toward hospital-based treatment (i.e., surgical intervention).

In many areas, the availability of non-surgical sources of care may be limited. None of the medical specialties, for example, are as equally distributed either across states (Morrow, 1977) or across urban-rural areas (ACS, 1975) as are general surgeons. General practitioners, on the other hand, are relatively plentiful; they are not only more evenly distributed across geographic areas than are any of the physician specialties (Morrow, 1977), but they constitute 17.1 percent of all patient care physicians (AMA, 1978). (General surgeons account for only 9.8 percent, although all surgical specialties total 29.9 percent.) Thus, the availability of general practitioners may provide a non-surgical treatment alternative for many patients and consequently reduce area surgery rates.

General practitioners may have an offsetting effect on shifts in surgery rates, however, for two reasons. First, surgery is also performed by non-surgeons, and to the extent that GPs are substitutes for surgeons, the GP-population ratio may raise demand for surgery. Unlike internists and pediatricians, GPs have traditionally supplied both surgical and medical services. A recent study of four geographic regions found that GPs performed 13.5 percent of all surgical procedures in area hospitals, but disproportionately more of such relatively simple procedures as vaginal deliveries, "D & C's", and tonsillectomies (Nickerson *et al.*, 1976a). Anecdotal evidence suggests, however, that many general practitioners have lost their hopsital appointments or had their privileges curtailed, and that this phenomenon is positively correlated with local surgeon density (Medical Economics, 1965; Medical World News, 1976; Owens, 1974). Second, GPs are a major source of referrals for surgeons, and thus may increase demand for surgery. Surgeons' usual fees have been found to be significantly higher in areas with high GP-population ratios (Sloan, 1976; Steinwald and Sloan, 1974).

Inducement by Surgeons

The demand for surgery may vary systematically as a function of the supply of surgeons. In particular, per capita surgery rates may be higher in areas of high surgeon-population ratios, even though fees are rigid downwards, as surgeons shift demand to offset falling workloads. As discussed in Chapter III, higher surgery rates in more physician-dense areas are consistent with both the neoclassical and inducement models. The key question is whether these higher rates are the result of normal market forces, including a downward movement (in fees) along a fixed demand curve, or result from a new equilibrium along an outward-shifted (induced) demand curve. If the entire demand curve is shifted, as opposed to just an increase in quantity demanded, this would be reflected by a positive physician supply coefficient in the structural demand equation.

Physician behavior is described in detail in the following supply section. For purposes of this discussion, it is useful to consider how inducement might take place from the consumer's (i.e., patient's) perspective. A patient presents certain symptoms and complaints to a surgeon. After conducting some diagnostic tests, the surgeon recommends surgery as a means of treating the condition. Let us assume that the patient has health insurance coverage for surgical services and that the coinsurance is low. In making the decision whether or not to undergo surgery, the patient faces considerable uncertainty. He may not only be ignorant about his medical care needs, but also unable to evaluate the proposed surgical intervention. The potential costs, in terms of future morbidity, may be high for both surgical and non-surgical alternatives. Unlike Pauly's movie camera,* our hypothetical patient can not try out this product before purchase, and he can not return it, should it prove defective. It is precisely because of this uncertainty and the patient's vulnerability that the physician's role as consumer agent has been socially sanctioned. This relationship is one of mutual trust, in which the patient understands that he is to cooperate with the physician to the best of his ability, and that the physician's behavior is governed by his (the patient's) welfare (Parsons, 1951). Thus, our hypothetical patient may agree to the recommended surgery, because of his implicit faith in the surgeon and in the outcome of the operation. Inducement enters the demand function precisely through the patient's belief that the physician is acting as his agent. Given a low net price due to health insurance, furthermore, the usual market constraints on inducement will be weak.

The Supply of Surgical Services

The supply of surgical operations is a function of the price of surgical services, certain physician characteristics, practice costs, and the extent of inducement, as measured by the surgeon-population ratio.

Price of Surgical Services

Under neoclassical assumptions, where the reimbursement rates for surgical services are high, surgeons will perform more operations, *ceteris* paribus. Surgeons will reallocate their time away from non-surgical work and leisure and into the more remunerative surgical activities. If the surgeon supply curve is backward-bending, however, a rise in average reimbursement levels may lead to a reduction in total hours worked, including hours spent in the operating room. According to this hypothesis, once the surgeon achieves a certain earnings level, he will choose an extra hour of leisure over an extra hour of work (the income effect), when fees increase. Unlike other workers, the self-employed surgeon does not face a fixed wage. Instead, the surgeon's wage will depend in large part upon his own work effort, and his hourly wages are expected to fall as the number of hours worked increases for the following reason.* The surgeon is the principal input to his practice and usually works alone or in a small group. His marginal product thus is determined primarily by his own hours-worked decision and will decline as total hours increase, due to fatigue, appointment scheduling difficulties, etc. The supply curve will be backward-bending under these conditions, because at higher prices, surgeons may choose to supply fewer rather than more services, as a function of certin income-leisure preferences.**

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* In an often-quoted analogy, Pauly (1974, p. 146) asserts confidence in purchasing a movie camera, despite his own ignorance, because there are knowledgeable consumers in the market who are able to evaluate price and quality. Reinhardt (1978) expands this analogy to show that the individual consumer still may not be able to intelligently choose among alternative *models* of cameras.

Whether the income effect dominates the substitution effect and if so, the wage level at which it occurs, and the magnitude of physician response, are still the subjects of intense investigation. Feldstein(1970) found negative price elasticities of supply based on time series data for the U.S.

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*See Sloan (1974) for a detailed discussion of this topic.

**Policy makers concerned about a possible "surplus" of surgeons might seek to reduce the number of physicians performing surgery. This could be accomplished by reducing the number of surgical residencies in order to restrict entry into the specialty, or by limiting reimbursement for operations to board-certified surgeons. Under either method, individual workloads would increase and so would surgical fees. If many surgeons are on the backward-bending portion of their supply curves, then the increase in price would lead to a net reduction in surgical output, as surgeons substitute leisure for work.

as a whole and concluded that the physician supply curve was backward-bending. The price elasticities varied considerably however (from -0.28 to -1.91), depending upon the specification of the regression equation. Based on 1960 and 1970 census data, Sloan (1975) analyzed the hours worked and weeks worked decision and found only weak support for the backward-bending supply curve hypothesis. The response of both weeks and hours worked to the wage variables was small and insignificant at plausible wage levels. Vahovich (1977) estimated supply equations for both a pooled sample of physicians and for individual specialties. He found significant evidence of backward-bending supply curves for hours worked by general practitioners, surgeons, and internists. Wage elasticities were generally low but still positive (0.21) when evaluated at the mean for the surgeon sample and turning negative when evaluated at one standard deviation above the mean (-0.36). Surgeons began to reduce their work effort at an hourly wage rate of $24.86. Almost one-third (31%) of the surgeons in the sample earned hourly wages above this critical level and hence were on the backward-bending portion of their supply curves.

Physician Characteristics

Surgeons with greater amounts of professional training and specialized credentials will face a greater demand for their services and will perform more operations. In addition, some hospital staffs may require evidence of competence before granting admitting and operating privileges to a new surgeon. Based both on time and motion studies and on self-reported data, board-certified surgeons have higher operative workloads than other surgical practitioners (Hauck *et al*., 1976; Hughes *et al*., 1975). They not only perform more total operations, but the average complexity of their caseload also is higher. Average work weeks do not vary between board-certified and non-board-certified surgeons, however, suggesting that the latter provide more non-surgical office-based care. Thus, we would expect to observe higher surgery rates in communities with a greater proportion of surgeons who are board-certified.

Older physicians generally have lower workloads, including operative workloads, for several reasons (Sloan, 1974; 1975; Vahovich, 1970). First, the older physician is likely to face a drop in demand for his services, as referring physicians send new patients to younger colleagues and as his own patients "retire" him. Second, the older physician may reduce his workload, due to failing health and/or increased preferences for leisure. Communities with a disproportionately "elderly" physician population are apt to have lower surgical rates.

Surgeons with a high time price also will supply fewer services. Female physicians with children should value their leisure time more highly and thus work fewer hours, a finding confirmed by Sloan (1975). Women represent such a small proportion (3.4%) of all patient care surgeons (AMA, 1976), however, that this is not expected to influence surgery rates.

Practice Costs

Surgeons operating in high cost areas should restrict supply, assuming rising marginal costs. Higher fees will be needed to cover fixed overhead costs of maintaining an office (e.g., rent, supplies) plus any auxiliary personnel. Because surgeons rely heavily on "free" hospital inputs to assist in operations, high input prices should be less important in constraining supply than for other, ambulatory types of care. Nevertheless, appendectomy fees have been shown to be higher for both general surgeons and GPs, where ancillary personnel wages are higher (Steinwald and Sloan, 1974).

Hospital beds constitute the major complementary input in the production of surgical services. Without available beds, the surgeon is unable to care for post-operative patients and must defer surgery. Holding demand constant, the surgeon can raise his own productivity by his use of hospital beds. Surgery rates are hypothesized to be higher in areas with higher hospital bed-population ratios.

Surgeons Per Capita

What happens to surgeon income and workload when there is an exogenous shift in the surgeon-population ratio? As the supply of surgeons increases (a rise in SURGPOP), surgical workloads fall and so do incomes. Surgeons try to regain previous income levels by lowering prices and increasing their workloads, as more services are demanded at this lower price. This response assumes, however, that surgeons are willing to work harder for the same income. By exercising their power to shift demand, surgeons can increase their workloads (and hence incomes), at the same price. If they have sufficient discretionary influence, furthermore, they may raise both workloads and prices in order to return to a target income. The source of this target income has always troubled economists, but a reasonable target would be the income attained prior to the increase in the surgeon-population ratio. (The concept of a target income is discussed in greater detail below.) Thus, we hypothesize that per capita surgery rates will be higher in areas where the surgeon-population ratio is higher, than would be predicted without inducement*, as surgeons shift demand to offset falling workloads.

A fall in individual surgical workloads also will encourage the supply of nonsurgical services. Anecdotal evidence has suggested that in surgeon-dense areas, general surgeons provide more non-surgical care in order to supplement their earnings (Owens, 1974). Of course, in this market surgeons must compete with other specialists and general practitioners as well. (This does not necessarily imply that surgeons have induced demand for non-surgical services.) Nevertheless, any evidence of inducement in operations is a minimum estimate of shift, as it probably is easier to shift demand for non-surgical care.

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*As discussed in Chapter III, this is difficult to test, as both the neoclassical and the inducement models predict increases in utilization.

How does inducement take place in the surgeon's practice? Faced with a declining caseload, the surgeon may simply recommend (and perform) additional services for his remaining patients. He chooses whether to recommend return office visits or more frequent check-ups, for example, or whether to perform a certain surgical procedure. While surgeons may be able to reallocate some of their professional time into non-surgical activities, their ability to do so will be constrained by the relative supply of other physician specialties. It is also reasonable to assume that surgeons will prefer to do surgery whenever possible, for two reasons. First, net hourly revenue will be higher for surgical activities, as the surgeon uses more free hospital inputs and incurs fewer office expenses. Second, the practice of surgery entails considerable professional prestige and personal satisfaction, which presumably is why the surgeon chose this specialty in the first place.

Under conditions of high surgeon density, the surgeon is hypothesized to exercise his discretionary ability to induce demand. He does so by encouraging surgical intervention for a patient's condition, when previously he might have recommended medical treatment. Given a high workload, the surgeon will allocate his time to non-elective surgical procedures. But as he has more time available, he is apt to perform more elective procedures. Where before he might have advocated no treatment for silent gallstones, he now recommends a cholecystectomy. Rather than suggesting drug therapy for menstrual irregularities, he now proposes a hysterectomy. Similarly, the surgeon now recommends coronary artery bypass graft surgery for patients with severe angina, when previously he would have treated such cases medically.

When the demand for surgical services for individual physicians is high, the surgeon may take a more conservative stance toward elective surgery. As demand falls, however, his perceptions of what constitutes elective surgery begin to change. What is responsible for this apparent shift in definition? First, the surgeon wants to maintain a high operative workload, both for his own professional satisfaction and in order to preserve his surgical skills. Second, he wants to remain at (or near) his previous income level. By recommending and performing more elective procedures, the surgeon can regain (or at least approximate) the income he earned prior to the rise in the surgeon-population ratio, i.e., his target income.

The creation of work to fill available time has been observed in bureaucratic contexts as Parkinson's law, and first applied by Reinhardt to the medical profession. It is important to recognize that inducement is not (necessarily) synonymous with the provision of unnecessary or medically useless services. Changes in recommended therapy, such as those described above, do not imply deception or misrepresentation on the part of the surgeon. There is sufficient divergence of medical opinion regarding the indications for the performance of elective surgery to give the surgeon considerable latitude in his decision-making (Koran 1975 a-b; Rutkow et al., 1979). Given a fixed level of illness in the community, however, the net social benefit of those services wil diminish over time. The social costs of reaching the saturation point are relativly large, both in terms of the negative health impact of "over-doctoring" and quality dilution, as well as the economic costs of investment and subsidy.

"Defensive" medicine will reinforce any shift effect, as surgeons seek to forestall potential malpractice suits, by performing diagnostic surgical procedures. The physician's training and background also predisposes him toward active intervention: to operate when in doubt. Inactivity is often difficult to tolerate, not only for the surgeon but for the patient and his family as well (Parsons, 1951).

The surgeon is hypothesized to shift demand in order to attain a target income. What is a target income, and how is it determined? Despite its frequent usage in the economic literature, the concept of a target income has never been explicitly defined. The following discussion will seek to develop one.

The target income is the amount of money earned through medical practice that the physician wants to achieve. As the physician's wage is not fixed but depends in large part upon his own work effort, he has considerable control over the size of his income. The actual target is determined through comparison with other physicians of the same specialty training and geographic location. Failure to achieve a target income, i.e., failure to earn as much as his peers, may be interpreted as a lack of professional ability. According to Mechanic (1979), the physician's clinical performance is critical to his self-imge. The work of the office-based physician, however, goes largely unnoticed by other physicians. His work is observed only by his own patients who are not capable of judging his technical abilities. As a result, the physician's income becomes an important symbol of his success. It is external evidence of high demand for his services, both on the part of patients and referrals from other physicians. Thus, the surgeon will seek to earn a net income comparable to those of his peers in order to maintain his professional self-esteem.

Model of Surgeon Location

The demand for surgery and the supply of surgical procedures are simultaneously determined, and hence the direction of causation may be ambiguous. Rather than inducing demand for their services, surgeons may locate in those areas where consumer demand is high. A model of surgeon location is critical to our analysis of surgical utilization.

Surgeons maximize utility by selecting a practice location that maximizes residential and professional amenities, subject to certain income-leisure preferences. The decision to locate in an area involves consideration not only of its environment, but also potential workloads and incomes.

Professional Amenities

Physicians tend to locate in areas where they can be near their colleagues and medical facilities. Specialists, including surgeons, are apt to be even more dependent on other physicians and hospital-based technological care. Fuchs and Kramer (1972) found that the presence of medical schools in a state was the single most important predictor of physician location, probably for two reasons. First, the medical school provides the most up-to-date technology in its teaching hospitals, and extensive opportunities for consultation. Second, it attracts medical students, and house staff, many of whom will later establish their practices nearby. A study of new medical school graduates found that prior attachment to a state exerted a strong influence on locational decisions (Yett and Sloan, 1974). Newly trained physicians were particularly likely to settle in the same state where they had completed their internship and residency.

The supply of hospital beds in an area also attracts physicians (Fuchs and Kramer, 1972; Joroff and Navarro, 1971; Marden, 1966) and it has been suggested that bed supply may be a proxy for the availability of medical facilities generally. It is much more than that; the supply of hospital beds is an important complementary input to the production of surgical services in two ways. First, the surgeon can not operate without an available bed. Where queues for hospital admission are long, surgery rates will be lower, particularly for elective procedures. Second, associated with hospital beds are nursing and house staff which the surgeon can use as free inputs in his care of patients.

Finally, although surgeons are fairly evenly distributed across urban and rural areas, they show a marked preference for metropolitan environments (Fuchs, 1978). Urbanization is really a proxy for both professional and residential amenities. Metropolitan areas are more likely to offer both the high-technology medical care and the social and cultural opportunities that surgeons find attractive. Surgeons with a strong preference for leisure also may gravitate toward urban centers, because workloads are lower.

Residential Amenities

Physicians also locate in areas that offer social and cultural opportunities, i.e., areas deemed attractive by high-income consumers. The appeal of a residential environment has generally been proxied by its racial distribution and population density. Physicians, including surgeons, tend to settle in predominantly white, urban communities (Fuchs, 1978). Other proxy measures for residential amenities have included the area's climate and its popularity as a vacation spot. Physicians are significantly more likely to locate in areas with warm weather (Yett and Sloan, 1974) and high hotel receipts (Fuchs, 1978).

Workload

Given high physician incomes nationwide, physicians may choose leisure over work and settle in metropolitan areas where patient loads are generally lower (because there are more physicians per capita). General surgeons in rural communities make 20 percent more hospital visits per week (a proxy for their operative workload) and 25 percent more office visits than do their urban colleagues (Owens, 1974).

Analytic attempts to explicitly incorporate anticipated workload into the physician's locational decision have not been successful. Yett and Sloan (1974) found that variations in physician effort across states, as measured by mean hours worked, did not predict the location of new medical school graduates. As expected workload may be endogenous to the location decision, Fuchs and Kramer (1972) included a predicted visits-per-physician variable in their location equations, but it was never significant.

Income

Physicians may be attracted to those areas where they can expect to earn high incomes, i.e., areas with high demand for their services. Thus, Fuchs and Kramer (1972) found that physicians were likely to locate in areas with high per capita incomes and high average prices for physician services.

Both utilization and price may be endogenous to physician supply, however, and Fuchs (1978) used predicted values for these variables in his two-stage estimation of surgeon location. Neither variable was significant, but as discussed in the literature review section, the market areas were probably misspecified. In a recent review of the physician location literature, Lave *et al*. (1975) conclude that income maximization is relatively less important and that professional and social amenities dominate the physician's decision-making.

Summary of Hypotheses

Our conceptual framework yields a number of secondary hypotheses regarding the demand for surgical operations and the supply of surgeons. For purposes of testing the inducement model, however, the primary focus of this analysis will be on the following hypotheses:

(1) Surgeons can and do shift demand for their services, i.e., per capita surgery rates are hypothesized to be higher in areas with higher surgeon-population ratios, *ceteris paribus*.

(2) Holding output constant, surgical fees are hypothesized to be higher in areas with higher surgeon-population ratios.

V. DATA BASES AND VARIABLE MEASUREMENT

Data Sources

Analytic variables were drawn from a wide range of sources, both published and unpublished, as summarized in Table V-1. These data bases are described in detail below.

Health Interview Surveys

The Health Interview Surveys from 1969 through 1976 were the major data base for this project. The Health Interview Survey is conducted annually by the National Center for Health Statistics and represents a probability sample of all U.S. households. It includes the civilian, non-institutionalized household residents who are alive at the time of the interview.

The Health Interview Survey is an interviewer-administered questionnaire that obtains information from all household residents on personal and demographic characteristics, illness and chronic conditions, and medical care utilization. Both the dependent variables (surgical utilization rates) and variables representing individual patient demand for surgical services were derived from this data base.

Utilization Rates: Since the Health Interview Survey is a probability sample, reported utilization of services could be used to develop population-based rates at the PSU level. This permitted a much finer micro-analysis of variations in utilization than has been possible with data aggregated at the state or regional level.

Our measures of utilization were rates of individual elective and total operations. Each survey respondent was asked to report all hospitalizations

TABLE V-1:

VARIABLE DEFINITIONS, SOURCES, AND MEANS

Variable	Description	Source	Mean
SR	total operations per 1,000 population	HIS	62.18
SRE	elective operations per 1,000 population	HIS	30.95
SP	surgeons per 1,000 population	AMA, *Physician Distribution in the U.S.*	0.30
W	annual operative workload	$\frac{SR}{SP}$	280.76
P	surgical fee index	Medicare prevailing charge data*	323.39
ELDPC	proportion 65 years and older	HIS	0.10
MIDPC	proportion aged 45-64 years	HIS	0.21
YAPC	proportion aged 21-44 years	HIS	0.44
F	proportion female	HIS	0.52
WHITE	proportion white	HIS	0.87
EDHS	proportion 9-12 years education (household heads)	HIS	0.47
EDCL	proportion 13 years education and more (household heads)	HIS	0.28
DISPC	mean bed disability days	HIS	0.25
EMPLOYED	proportion employed	HIS	0.58
PROF	professional and technical workers, managers (proportion of labor force)	HIS	0.26

TABLE V-1: Cont'd

VARIABLE DEFINITIONS, SOURCES, AND MEANS

Variable	Description	Source	Mean
CLERK	clerical, sales, and service workers (proportion of labor force)	HIS	0.35
BLUEC	craftsmen, operatives, and laborers (proportion of labor force)	HIS	0.34
INC	mean family income (in 1,000s)	HIS	10.7
COIN	proportion of hospital expenses covered by third party payors	predicted from state insurance regression	0.84
HEXPA	hospital expenses per admission in (100s)	American Hospital Guide issue tapes	10.85
GPPC	general practitioners per 1,000 population	AMA, Physician Distribution in the U.S.	0.23
NSP	surgeons in adjacent SMSA per 1,000 population in non-SMSA and adjacent SMSA	AMA, Physician Distribution in the U.S.	0.04
WAGE	hourly wage for employees in retail trade	U.S. Census, Census of Retail Trade, 1967, 1972, 1977.	2.18
DEGD	degree days (in thousands)	Statistical Abstracts	4.46
HOTLPC	hotel receipts (in thousands) per capita	U.S. Census, Economic Surveys-Selected Service Industries, 1967, 1972, 1977.	0.05
SMSA	proportion residing in SMSA	HIS	0.67
BEDPC	short-term general hospital beds per 1,000 population	American Hospital Assoc. Guide issue tapes	4.55
COLLG	number of colleges and universities	1969: College Blue Book 1970-76: Chronicle of Higher Education	9.01

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*U.S. Senate Subcommittee on Finance, Medicare and Medicaid: Problems, Issues and Alternatives (1969). Personal Communications from Medicare Part B carriers (1970-1973). HCFA Medicare Directory of Prevailing Charges (1974-76).

and surgical procedures experienced during the previous twelve months. The following items were included:

(1) The data of hospital admission;

(2) The number of nights spent in the hospital;

(3) The medical condition requiring hospitalization; and

(4) The name of the surgical procedure(s) performed (if any).

The use of self-reported utilization data from patient interviews posed questions regarding the accuracy of these data. In particular, we were concerned about non-response bias and the extent to which persons may have underreported hospital episodes because of poor recall. Possible measurement error in the HIS Survey is discussed in detail later in this chapter.

Demand Variables: The Health Interview Survey also included the following socio-demographic variables and health status variables for each member of the household: age; sex; race; highest level of education attained for all membbers 17 years and over; total family income; occupation and employment status; and bed disability days. All of these variables were expected to influence the demand for surgical and hospital services.

In addition, we had planned to use biannual data collected from the Health Interview Survey to construct a health insurance coverage variable. Preliminary independent analysis revealed considerable measurement error in these data, neccessitating an alternative approach for our purposes. Adequate time-series insurance information by small geographic area are non-existent. Instead an average coinsurance rate for hospital services was constructed by state for each of the years in our time-series. Then, using parameter estimates from a state insurance regression, a predicted coinsurance rate was generated for each PSU. A detailed description of this procedure is provided in Appendix A.

Physician Fee Data

Market prices for different surgical procedures were proxied by the Medicare prevailing charge. The prevailing charge is the "maximum allowable payment" set by Medicare and is currently established at the 75th percentile of usual and customary charges in a given geographic area. As prevailing charges are based on usual and customary physician fees for the previous year, the 1970-1977 Medicare prevailings were used to construct prices for 1969-1976. Fee data for 1974-1976 were obtained from the annual Medicare Directory of Prevailing Charges, and for 1969 from a U.S. Senate Finance Committee report. Published Medicare charge data were not available for 1970-1973, and were obtained directly from the Medicare Part B carriers under the Freedom of Information Act. Surgical fees were consistently available for six procedures: Cholecystectomy, hernia repair, hemmorhoidectomy, lens extraction, prostatectomy, and radical mastectomy.

Other Data Sources

Data on the supply of surgeons, general practitioners, and total physicians were obtained from Physician Distribution in the U.S., an annual American Medical Association publication. The annual American Hospital Association Guide issues were used to construct the total number of short-term general hospital beds in the PSU, and the average expense per hospital admission. Data sources for the variables measuring professional and residential amenities are described in Table V-1.

Measurement of Elective Surgery

Elective surgery was conceptually defined as those operations which meet the following criterion:

(1) They can be scheduled in advance, i.e., they are not emergency procedures.

In addition, at least one of the following must be met:

(2) They are discretionary on the part of both physician and patient, in that lack of surgery poses only a morbidity, not a mortality, threat to the patient; and/or

(3) The scientific evidence does not indicate clearly greater average life expectancy if surgical treatment is chosen.

Thus, operations resulting from accidents, violence, and child-bearing were explicitly excluded.

The HIS surgery codes were classified as elective or non-elective, based on this conceptual definition, by a panel of physicians. Any operations resulting from trauma or associated with a cancer diagnosis, including those in the "definitely elective" category, were considered non-discretionary surgery. Where there was disagreement as to the elective nature of the operation, or where HIS codes were not sufficiently detailed to permit classification, the procedure was assigned to the non-elective category. (All obstetric procedures, including abortions, were excluded from the analysis entirely and not counted in total surgery rates.)

The development of both the conceptual and operational definitions of elective surgery is described in greater detail in Appendix C.

Measurement of Surgery Market Areas Using HIS Primary Sampling Units

The Health Interview Survey is based upon a sample of 349-360 primary sampling units (PSUs)* drawn from the universe of 1900 geographically defined

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*Beginning in 1973, the sample design was modified by NCHS based on the 1970 census. As a result, some PSUs were expanded to reflect metropolitan growth. In other instances, some (usually rural) PSUs were deleted, and new ones substituted. Thus while each year represents a national probability sample, the number of PSU observations varies somewhat from one time period to the next.

PSUs covering all 50 states and the District of Columbia. A PSU generally consists of a county, a small group of contiguous counties, or a standard metropolitan statistical area (U.S. National Health Survey, 1958). The market area for surgical services was defined as the PSU, where the PSU consists of an SMSA or a county (or group of counties) that is not continguous with an SMSA. This definition has several advantages over the large geographic aggregates used in previous studies. First, small geographic areas, such as a county or SMSA, are more appropriate for the analysis of health care services. Patients generally seek medical care, including surgery, from local physicians and hospitals. Second, the HIS-defined PSUs cross state boundaries, when indicated by existing trade and commuter patterns. Thus, the Louisville SMSA, for example, includes two Indiana counties and one Kentucky county.

As HIS data are reported for individuals rather than for communities, market area characteristics were constructed at the PSU level, e.g. age and income distribution, surgery rates, etc. All individual observations were weighted, using the basic weights developed by NCHS to obtain national estimates. The final analytic file included 2,837 observations, 8 years times 349-360 PSUs in each year. All secondary data (described in Table V-1) were merged on by year at the PSU level.

Border-Crossing

While inter-PSU analysis permits a much finer microanalysis of variations in surgery rates than regional aggregates, these small areas raise potential problems of border-crossing. To the extent that patients cross geographic boundaries in search of surgical services, correlations between utilization and supply will be spurious.

When the PSU consists of an entire metropolitan area (SMSA), it is also the relevant market area for surgeons' services and most SMSA residents probably receive their care within the PSU. As HIS surgery rates are population-based, in-migration will not bias these rates upwards. Patients from rural areas, however, may cross into an adjacent SMSA area to seek surgical services. In this instance, demand for surgery in non-SMSA areas may be influenced not only by the number of surgeons in the non-SMSA area, but also by the supply in the neighboring metropolitan area.

The locations of PSUs in the Health Interview Survey sample were carefully examined to see whether border-crossing is a problem; of particular concern were rural PSUs and contiguous metropolitan PSUs. Contiguous SMSAs were found only in four instances; those adjacent metropolitan areas were merged and treated as a single PSU for analytic purposes.

All rural (non-SMSA) PSUs were examined to determine their geographic locations. If the PSU was not adjacent to an SMSA, we assumed that border-crossing is not a problem. When the PSU is adjacent, it is possible that these PSU residents travel to the neighboring metropolitan area to see a surgeon. Border-crossing appeared likely in over one-half of the non-metropolitan PSUs in the 1969 - 1976 time-series. In these cases, we included an additional surgeon supply variable, a technique used by Fuchs (1978). This variable was defined as the number of surgeons in the adjacent SMSA per 1,000 population, where the population is defined as the SMSA plus rural PSU resident population.

Sources of Measurement Errors in HIS

The use of self-reported utilization from patient interviews poses particular questions regarding the validity and accuracy of these data.

Patient interview surveys contain two sources of measurement error that may bias estimates upwards or downwards: non-response bias and field bias.

Non-Response Bias

Non-response bias is introduced by individuals who refused to participate or, for some other reason, were not interviewed. While persons may refuse for a variety of idiosyncratic reasons, non-respondents nevertheless do not appear to be distributed randomly in the population. To the extent that non-respondents do differ from respondents and to the extent that these differences are correlated with differences in medical care utilization, total estimates will be biased. Previous analyses of the CHAS household interview surveys indicate that the health service experiences of non-respondents are indeed different (Andersen, 1975). Non-respondents were both less likely to have visited a physician in the past year and less likely to be admitted to the hospital. NCHS, however, reports low refusal rates associated with the HIS (U.S. National Health Survey, 1958), and we do not expect that our estimates of surgery rates are biased downwards for this reason.

Self-reported data may also underestimate surgical utilization through a less obvious source of non-response bias, i.e., those persons who have died during the reference period. A mortality survey of hospital utilization during the last twelve months of life found that household surveys greatly underestimated admissions, especially for males and for the elderly (NCHS, 1965). The best source of utilization data for decedents was the medical institution itself; relatives of the deceased greatly underreported the number of admissions. When health survey data were adjusted for deaths, the number of hospital discharges increased by 9 percent and the days of care rose 14 percent. For the population aged 65 years and over, however, the adjustments increased hospital utilization over survey estimates by more than 25 percent for females, and over 50 percent for males. Thus, the exclusion of persons dying during the sample year will lead to some underestimate of surgery rates. Since this is constant across PSUs, however, it does not affect our inter-area analysis.

Field Bias

Field bias is introduced when persons report inaccurate or incomplete information during the interview. Poor reporting can be attributed to two factors: memory and motivation. First, persons simply may not recall certain health events, either because they occurred in the relatively distant past, or because they were perceived as trivial. Second, the nature of the illness may lead people deliberately or unconsciously to distort the event or to suppress its occurrence entirely. Memory and motivation clearly are interactive effects; their joint impact appears to be stronger than either effect alone.

The accuracy and completeness of reporting appears to vary with both individual characteristics of the respondent and characteristics of the hospital or illness episode. Older persons (65 years or over) and non-white persons are likely to underreport hospital admissions (NCHS 1965 a-b).

Higher education improves reporting accuracy, although family income exerts a much stronger positive effect. These reporting differences should not influence our analysis of surgery rates, for two reasons: (1) the relative differences are not expected to have changed over time; and (2) age, race, education, and income were controlled in the analysis. In addition, reporting accuracy improves dramatically for longer hospital stays and more serious conditions (NCHS, 1965 a-b). Similarly, surgical hospital episodes are more likely to be reported than those that had not involved a surgical procedure.

Finally, the studies conducted by NCHS (1965 a-b) have also shown that the rate of underreporting increased sharply as the time elapsed between the hospital discharge and the interview increased. Respondents underestimated hospitalizations by 10 percent for the twelve month period preceding the interview, but only less than 5 percent for the previous six months.

VI. DESCRIPTIVE RESULTS

This chapter presents descriptive statistics, illustrating the variations in surgery rates, surgeon-population ratios, and surgical fees. Obstetric procedures were excluded from the calculation of surgery rates, as they are dependent on conception and birth rates and not of analytic interest. Both total and elective surgery rates have been age and sex adjusted to remove the effect of age and sex as explanations of differences between PSUs. Surgery rates were standardized, using the traditional indirect method, as follows (see Hill, 1977, pp. 190-192):

$$(SR_i)_{adj} = \frac{SR_N}{(SR_i)_{exp}} \cdot (SR_i)_{obs}$$

where $(SR_i)_{adj}$ = the surgery rate in the i-th PSU, age-sex adjusted; SR_N = the national surgery rate; $(SR_i)_{exp}$ = the expected surgery rate in the i-th PSU; and $(SR_i)_{obs}$ = the observed surgery rate in the PSU. (A direct age-sex adjustment to the observed surgery rate was not possible because age-sex surgery rates were unavailable at the PSU level. Thus national age-sex population weights could not be applied directly to PSU age-sex rates.)

As an example of the indirect method, using only a binary sex adjustment, assume PSUs 1, 2, and the Nation (N) have the following sex distribution and surgery rates (unobserved at the PSU level):

PSU	Sex Dist.		Surgery Rate/1000
1	M	.4	50
	F	.6	60
	T	1.0	56
2	M	.5	50
	F	.5	60
	T	1.0	55
N	M	.5	60
	F	.5	80
	T	1.0	70

The two PSUs exhibit overall rates of 56 and 55, but as we can see, all the difference is due to their different population mix and not to underlying differences in rates. Using the indirect formula, the adjusted rates for the two PSUs would be:

$$(SR_1)_{adj} = \frac{70}{(.4 \cdot 60 + .6 \cdot 80)} \cdot 56 = .97 \cdot 56 = 54.44$$

$$(SR_2)_{adj} = \frac{70}{(.5 \cdot 60 + .5 \cdot 80)} \cdot 55 = 1.0 \cdot 55 = 55.0$$

Thus, the adjusted rate for PSU 1 falls to slightly below that of PSU 2 because of the higher-than-average concentration of females. PSU 2's adjusted rate is unchanged because its sex distribution mirrors that of the nation as a whole. Theoretically, while the two adjusted rates should be identical (say equal to 55 using natural weights), a slight discrepancy remains using the indirect method because of the use of national surgical rates (which show a greater spread in male-female surgery) rather than PSU-specific rates.

Inter-temporal Variation

Table VI-I presents national means for the years in our time-series for total and elective surgery rates, surgeon-population ratios, the surgical fee index (both unadjusted and adjusted for cost-of-living and inflation), and surgical expenditures per capita (cost-of-living adjusted). The surgical fee index is a weighted index of six surgical procedures, using the national frequency of these operations as the weights. Surgical expenditures are a simple product of total operations and the COL-adjusted fee index, expressed on a per capita basis for the PSU.

As these HIS surgery rates are based on a 12-month recall, they are considerably lower than those rates derived from medical record abstract

TABLE VI-1:

CHANGES IN SURGERY RATES, SURGEON SUPPLY AND FEES OVER TIME

	Total Operations per 1,000	Elective Operations per 1,000	Surgeons per 1,000	Surgical Fee Index	Adjusted Fee Index	Adjusted Surgical Expenditures Per Capita
1969	59.56	30.63	0.284	$283.11	$293.61	$17.43
1970	60.25	31.48	0.291	335.00	326.04	19.61
1971	59.73	30.64	0.296	361.02	342.84	20.39
1972	60.71	30.93	0.304	382.90	348.23	20.93
1973	63.05	30.86	0.299	401.85	333.61	20.92
1974	64.43	30.67	0.308	422.68	308.46	19.78
1975	64.41	31.50	0.314	456.09	311.31	19.89
1976	63.22	29.57	0.319	495.33	319.67	20.00
Net Δ 1969-76	+6.33%	-3.46%	+12.32%	+74.96%	+8.88%	+14.74%

studies. The Hospital Discharge Survey, also conducted by NCHS, reported 89.3 operations per 1,000 in 1976, excluding obstetric procedures (NCHS, unpub.). Differences in sample design and variable definition between the two surveys also contribute to the discrepancy in surgery rates in any given year.* As there is no reason to believe that poor recall varies systematically with surgeon density or fees, this underreporting will not influence our econometric analysis. (Variables that do affect reporting accuracy, such as age and education, are held constant.)

Based on HIS data, total surgery rates have increased only 6.33 percent from 1969 to 1976, in marked contrast to NCHS hospital discharge survey estimates of 22.7 percent (NCHS, 1973; unpub.). It seems unlikely that reporting accuracy has deteriorated in the population at large during the last decade. What does seem likely, however, is that diagnostic surgical procedures have been increasing at a more rapid rate than other operations, and that these procedures may be more susceptible to underreporting. Diagnostic surgical operations range from relatively simple procedures, such as biopsies, to more complex cardiac catheterization. These procedures have been growing largely due to the development of new medical technology in this area, especially fiberoptics. Although HIS interviewers are instructed to code these procedures as operations, it is probable that many diagnostic procedures go unreported by sample respondents. Many individuals may simply not have perceived such procedures as surgical operations, and hence not have volunteered this information to the interviewer. The fact that a number of these diagnostic procedures may be performed outside an operating room, or without general anesthesia, will reinforce such perceptions.

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*The HIS exclusion of persons dying during the sample year also leads to some underestimate of surgery rates.

Elective surgery rates actually show a small net decline, -3.46 percent. This is probably a function of the specific procedures composing the elective surgery variable. Hospital discharge survey data confirm that several elective operations have fallen dramatically over time (NCHS, 1973; unpub.). For example, tonsillectomy rates have decreased 46 percent from 1968 to 1977, varicose vein excision 40 percent, and hemmorhoidectomy 21 percent. (See Table II-1.) The substantial increase in surgeon supply, 12 percent, is consistent with estimates from other secondary data sources (ACS, 1975). The expansion in supply over this time period not only resulted in higher average surgeon-population ratios (from 0.28 per 1,000 to 0.32), but improved access to surgical services. The number of PSUs with no surgeons whatsoever declined steadily, from 41 in 1969, to only 18 PSUs in 1976. By 1976, only 3.1 percent of the U.S. population was living in these surgeon-less counties, compared with 4.4 percent eight years earlier.

Surgical fees exhibit a dramatic increase over the eight-year time period, despite the expansion in supply. Nominal surgical fees increased 75 percent, from $283 on average in 1969 to $495 in 1976. Fees actually accelerated faster than the cost-of-living; after adjustment for inflation and geographic cost-of-living differences, we observe a real increase of almost 9 percent. (All adjusted monetary variables are expressed in 1969 dollars.)

Nominal surgical expenditures increased by an extraordinary 84 percent, from $16.79 per capita in 1969 to $30.89 eight years later. Of course, most of this increase was due to general inflation, but as seen in Table VI-1, deflated expenditures rose by about 15 percent, as a result of increases in both price and quantity.* What has been the total cost of these increases, holding constant inflation and population shifts? National surgical expenditures rose from \$3.5 billion to \$4.3 billion (in 1969 dollars) over the eight-year period. Netting out those increases due solely to population _growth_ (the shift in age composition is adjusted through the rates themselves), we obtain a real cost to society of \$553 million (or \$2.9 billion in nominal terms!). Of this, approximately \$230 million can be attributed to increased utilization (as a result of exogenous demand shifts, or inducement, or both), and \$323 million to fee increases above and beyond inflation. Surgeons' fees, however, represent only the tip of the iceberg; the cost of hospitalization averages four times that of the operation itself (\$1,239 on average in 1976, COL adjusted, vs. \$320). If we include hospitalization costs, total surgical expenditures for 1976 were \$20.8 billion in 1969 dollars, an increase of 43 percent from 1969.* This almost triples the net real cost to society, from \$553 million to \$1,448 million. Thus, failure to include hospital prices will underestimate the true economic impact of an outward shift in demand for surgery (whatever its source).**

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*Our estimates of surgical expenditures will be biased downward for two reasons: (1) the exclusion of obstetric procedures from our measure of surgery rates; and (2) under-reporting by HIS respondents. What happens if we re-calculate per capita surgical expenditures, substituting total surgery rates from the Hospital Discharge Survey for our HIS rates? The growth rate in COL-adjusted expenditures more than doubles (35.8%), from $22.46 per capita in 1969 to $30.50 in 1976.

Regional Variation

The variation in surgery rates across PSUs in 1976 is illustrated in Figures VI-1 and VI-2. Total surgery rates display a strikingly normal distribution across market areas (figure VI-1), but with considerable variation ranging from 11 to 153 operations per 1,000 (C.V.=29%). Of particular interest is the fact that we observe as many PSUs 1 S.D. above the mean (PSUs that average 86 operations or more per 1,000 residents) as there are 1 S.D.

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* Our measure of hospitalization costs is based on average hospital expenses for all admissions. If surgical hospital stays tend to be longer or require more intensive inputs (e.g. ICU care), then our measure of hospital costs may understate the true costs for surgical patients.

**Valuing the opportunity costs of time lost due to surgery would increase total expenditures even further.

FIGURE VI-1: AGE AND SEX - ADJUSTED SURGERY RATES (1976)

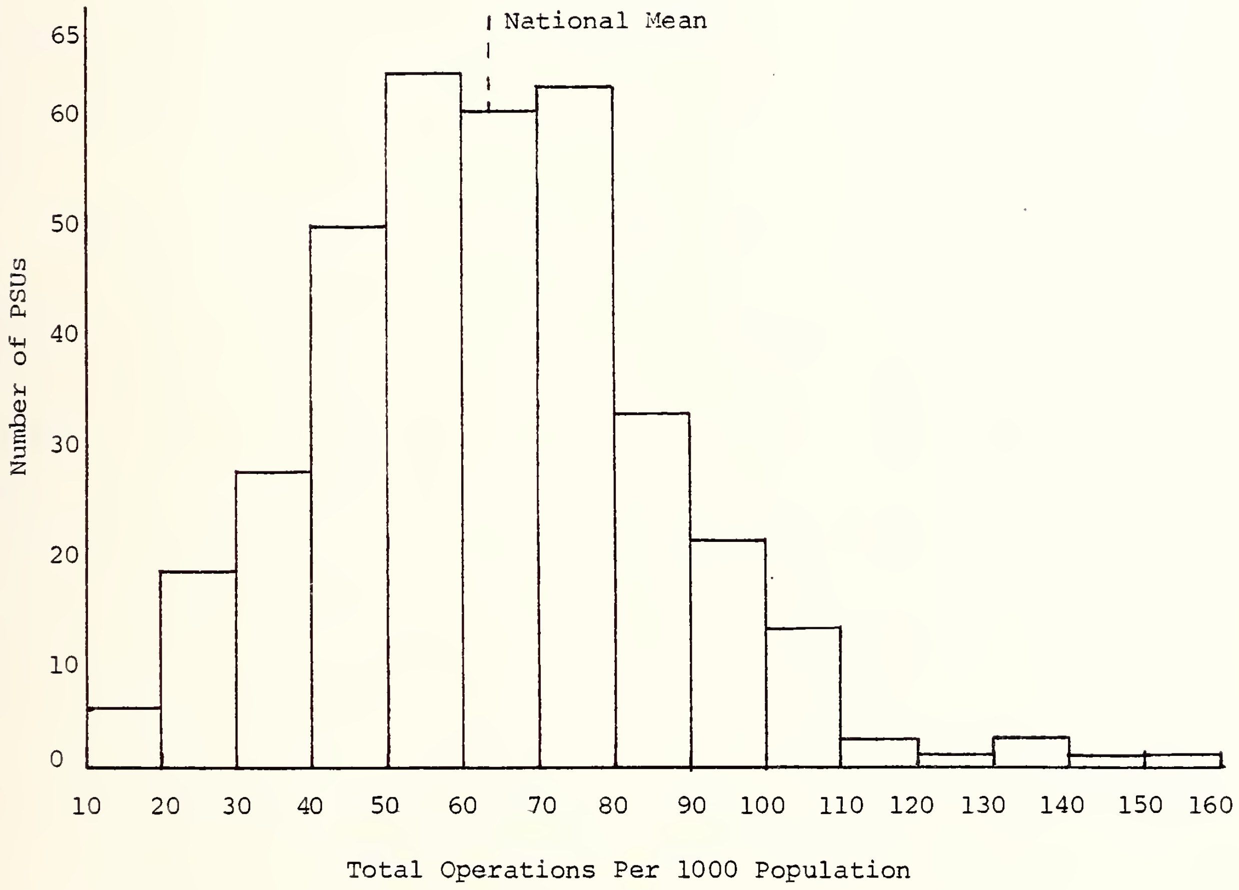
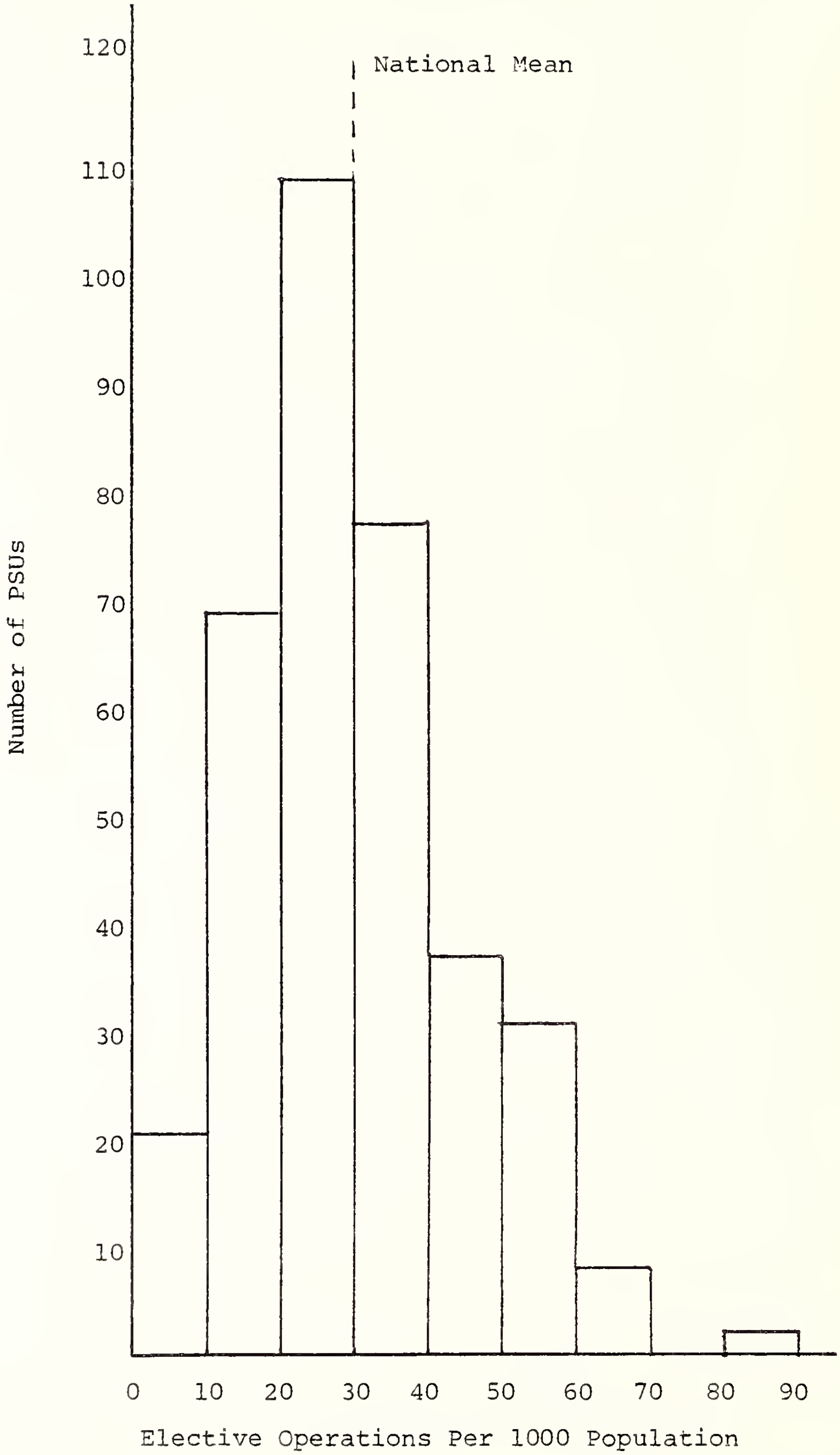


FIGURE VI-2: AGE AND SEX - ADJUSTED ELECTIVE SURGERY RATES (1976)



below (41 or fewer operations). This suggests that access to surgical services may be as much of a problem as overutilization. If however, as we suspect, the high surgery rate PSUs tend to be large cities, and the low surgery rate PSUs rural areas, then overutilization may be a far greater problem in terms of number of people affected.

Elective surgery rates show even greater variation across PSUs, ranging from zero to 86 (C.V. = 40%). One out of every six PSUs experience discretionary rates of 44 operations or more. This is not unexpected as discretionary operations, by their very nature, should be more sensitive to factors other than medical need, e.g. ability to pay, surgeon availability, etc.

Table VI-2 presents 1976 cross-sectional data by census division for surgery rates, workloads, fees, and physician supply variables. With the notable exception of the Mountain states (and elective operations in the Pacific division), there is relatively little regional variation in surgery rates. There is considerable intra-regional variation (as shown by the minimum and maximum values); in fact, the within-region variation exceeds the between-region variation for virtually all of the variables displayed in Table VI-2. This suggests that previous studies focussing on regional variations may have overlooked much of the true variation. Regional differences presumably reflect gross differences in such factors as consumer attitudes, medical practice, etc. Small area variations, on the other hand, reflect large differences in multiple demand and supply factors, including sociodemographic characteristics, ability to pay, and surgeon availability. For example, an important demand variable, percent of population white, ranges from 77 to 90 percent across the four census regions; across our sample of PSUs, however, it varies by a factor of three, from 33 to 100 percent white.

TABLE VI-2:

MEAN UTILIZATION, FEE, AND SUPPLY CHARACTERISTICS BY CENSUS DIVISION (1976)

(ranges in parentheses)

	New England (11)	Mid Atlantic (39)	East N. Central (66)	West N. Central (36)	South Atlantic (69)	E. South Central (34)	W. South Central (41)	Mountain (20)	Pacific (33)
Operations per 1,000	69.05 (41,107)	61.49 (21,137)	65.93 (24,111)	61.72 (26,114)	62.79 (17,109)	66.25 (16,153)	65.86 (23,143)	49.62 (16,89)	63.48 (11,132)
Elective Operations per 1,000	30.80 (16,47)	29.84 (0,81)	32.53 (6,67)	31.17 (8,60)	28.69 (0,69)	31.63 (0,59)	33.09 (5,86)	21.66 (0,51)	24.37 (0,65)
Annual Operative Workload	201.26 (142,334)	220.28 (49,531)	390.31 (0,2827)	558.85 (0,4820)	288.32 (0,1395)	487.88 (0,2260)	361.18 (0,2385)	274.89 (0,1584)	210.33 (0,974)
Surgical Fee Index	$259.04 (243,298)	$313.72 (227,515)	$276.54 (237,422)	$273.64 (240,315)	$311.27 (240,407)	$290.97 (253,324)	$315.98 (268,449)	$304.07 (254,381)	$351.58 (273,479)
Surgeons per 1,000	0.36 (.19,.52)	0.30 (.15,.49)	0.24 (.0,.72)	0.24 (.0,.71)	0.29 (.0,.65)	0.23 (.0,.75)	0.25 (.0,.47)	0.30 (.0,.57)	0.34 (.0,.52)
GPs per 1,000	0.21	0.21	0.23	0.24	0.29	0.23	0.25	0.30	0.34
Total Patient Care MDs per 1,000	1.29	1.25	0.96	1.15	1.09	0.89	0.95	1.09	1.30
Surgical Expenditures per capita	$17.91	$18.69	$18.13	$16.82	$19.52	$19.29	$21.07	$14.91	$22.29
Proportion Living in SMSA	0.37	0.59	0.53	0.31	0.39	0.38	0.51	0.40	0.67

Census divisions with higher surgeon-population ratios tend to have higher fees and lower surgical workloads. Compare, for example the Mid-Atlantic and West North Central regions.* The Mid-Atlantic region has 25 percent more surgeons per capita, but since surgery rates are virtually identical between the two regions, Mid-Atlantic surgeons carry surgical caseloads of 220 patients on average, compared with 559 for West North Central surgeons.** Despite their lighter workloads, Mid-Atlantic surgeons enjoy cost-of-living adjusted fees 15 percent higher than those in the the other region. With greater surgeon density, economic theory would predict lower fees through increased competition; yet mean surgical fees are actually higher. Other demand-supply factors may be correlated with surgeon concentration, however, and any determination of causation must await the econometric analysis presented in the next chapter.

Areas with higher fees tend to experience higher expenditures per capita, as there are no real inter-regional differences in utilization rates. The one exception is the Mountain census division where very low surgery rates contribute to per capita expenditures 21 percent below the national mean, despite its average surgical fees.

Variation Across Large, Small, and Non-Metropolitan Areas Over Time

Examining nationwide trends in surgery rates, fees, and surgeon supply may mask disproportionate rates of increase in particular geographic areas.

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* The West North Central region includes the Dakotas, Minnesota, Kansas, Missouri, Iowa, and Nebraska.

**Certain maximum values for the surgical workload variable are unusually high. Some of the operations in these communities, particularly in non-metropolitan areas, may be performed by general practitioners. (GPs were not included in the denominator of the workload variable.) We will empirically test this later.

Table VI-3 presents time-series data for large, small, and non-metropolitan areas. Large metropolitan areas were defined as those with populations of 500,000 or more.

While in 1969, non-metropolitan PSUs displayed significantly lower total and elective surgery rates, by 1976 they had achieved per capita rates roughly comparable to those in metropolitan areas. Analysis of variance results (not shown) reinforce these findings. In 1969, metropolitan/non-metropolitan location explained 2 percent of the variation in both total and elective surgery rates. By 1976, less than 0.1 percent of inter-PSU variation was attributable to location. The cross-tabular evidence suggests this was probably due to the large influx of surgeons over the eight-year period, an increase of 20.5 percent.* It also suggests that the positive correlation between surgery rates and surgeon supply is not necessarily evidence of inducement, as there may have been considerable excess demand for surgery in rural areas. Pooling non-metro and metro areas, therefore could lead to an overestimate of demand-shift. In our econometric analysis, we will examine this directly by estimating our model for these three subsamples separately.

Despite these gains, rural areas even by 1976 still have only half as many surgeons per capita as the SMSAs. At the same time, the supply of GPs has fallen across all areas, even in the non-metropolitan areas. Although, the net effect appears to be an increase in total physician-population ratios, the percent change is much lower for the rural PSUs, an increase of only 3 percent from 1969 to 1976 compared with 14 and 8 percent respectively for the two metropolitan groups. More important than the net addition to physician stock over time is the change in physician mix; surgeons appear to be increasingly substituted for general practitioners.

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*This percentage increase is particularly large due to PSUs, that previously had no surgeons, gaining at least one over the time-series.

Table VI-3:

INTERTEMPORAL CHANGES IN SURGERY RATES, PHYSICIAN SUPPLIES, AND FEES ACROSS LARGE, SMALL, AND NON-METROPOLITAN AREAS

	Total Surgery			Elective Surgery			Surgeon Supply			GP Supply		
	Non	Small	Large	Non	Small	Large	Non	Small	Large	Non	Small	Large
1969	55.7	63.1	61.0	28.0	32.8	31.7	.161	.328	.349	.291	.223	.242
1970	56.7	62.6	61.9	29.4	31.7	32.7	.169	.338	.356	.279	.223	.233
1971	59.4	60.4	59.8	29.9	29.9	31.3	.173	.363	.361	.276	.213	.226
1972	57.8	65.7	61.5	29.3	31.8	31.8	.181	.373	.367	.269	.206	.219
1973	61.1	65.6	63.3	30.0	32.8	30.8	.174	.345	.356	.258	.206	.207
1974	64.4	63.4	64.7	30.0	31.3	30.9	.183	.351	.363	.255	.202	.204
1975	64.6	63.7	64.5	31.0	32.1	31.6	.187	.356	.373	.248	.200	.199
1976	63.7	61.1	63.6	30.4	27.4	29.7	.194	.358	.378	.246	.200	.195
Net Δ 1969-76	+14.5	-3.2	+4.3	+8.6	-16.2	-6.3	+20.5	+9.1	+8.3	-15.5	-10.3	-19.4

Table VI-3 (cont'd)

	Total MD Supply			Surgical Fees			Surgical Fees (Adj.)			Surgical Expenditures p.c.		
	Non	Small	Large	Non	Small	Large	Non	Small	Large	Non	Small	Large
1969	0.70	1.22	1.60	$265	$263	$299	$298	$284	$294	$16.6	$17.7	$17.9
1970	0.70	1.18	1.59	301	309	360	318	313	334	18.1	19.6	20.5
1971	0.71	1.26	1.64	322	325	395	333	320	354	19.7	19.4	21.1
1972	0.72	1.30	1.64	339	344	419	338	324	360	19.4	21.2	21.8
1973	0.69	1.29	1.64	351	365	443	313	310	353	19.1	20.4	22.1
1974	0.70	1.30	1.66	367	382	464	287	286	326	18.6	18.2	20.9
1975	0.71	1.34	1.69	395	411	503	289	289	330	18.6	18.4	21.0
1976	0.72	1.39	1.73	430	445	547	299	295	339	19.0	17.9	21.2
Net Δ 1969-76	+2.9	+13.9	+8.1	+62.3	+69.2	+82.9	+0.3	+3.9	+15.3	+14.5	+1.1	+18.4

As expected, nominal surgical fees are consistently highest in the large metropolitan areas ($547 in 1976), and lowest in non-metropolitan areas ($430). Although fees increased in all areas, they increased at a much higher rate in the largest cities (83% compared with 62% in non-SMSAs). Most striking is the effect of the cost-of-living deflator on these prices. All of the real increase in surgical fees occurred in the large metropolitan PSUs, despite their high surgeon concentration and apparently low workloads. Why are fees rising so much faster in these cities? It is not because the rate of inflation is disproportionately higher, as we have already adjusted the surgical fee variable for these differences. Are surgeons able to raise prices, despite increased surgeon density? We will examine this directly in the following chapter.

Time-Series and Cross-Sectional Variation Across SURGPOP Areas

Based upon a frequency distribution of the surgeon-population ratios (SURGPOP), the PSUs were first divided into three groups: (1) one standard deviation (S.D.) or more below the mean (low SURGPOP); (2) ±1 S.D. (average); and (3) those whose surgeon-population ratio exceeded 1 S.D. above the mean (high SURGPOP). Table VI-4 presents mean utilization, fee, and supply characteristics for each of these three groups over time. Many of the findings are similar to those of Table VI-3, which shows that the metropolitan/non-metropolitan distinction is a good proxy for high/low SURGPOP areas. While total and elective surgery rates were well below average in 1969 for the low SURGPOP group, they increased more rapidly over time than in the other areas. The relative supplies of surgeons and GPs rose and fell (respectively) in all areas, but at faster absolute rates in the low SURGPOP areas (because of their very low and very high baseline levels). Finally, surgical fees (both nominal and real) have risen relatively faster over the

Table VI-4:

INTERTEMPORAL CHANGES IN SURGERY RATES, PHYSICIAN SUPPLIES,
AND FEES ACROSS LOW, AVERAGE AND HIGH SURGPOP AREAS

	Total Surgery			Elective Surgery			Surgeon Supply			GP Supply		
	Low	Average	High	Low	Average	High	Low	Average	High	Low	Average	High
1969	52.3	61.1	59.9	24.5	31.9	30.9	.036	.249	.395	.332	.245	.246
1970	50.9	61.0	62.3	25.4	31.7	33.0	.040	.259	.403	.314	.237	.240
1971	59.5	60.3	59.2	28.3	31.2	30.8	.042	.267	.412	.315	.231	.230
1972	57.3	62.0	60.3	28.4	32.1	30.3	.045	.276	.421	.306	.222	.225
1973	62.4	64.1	61.9	29.2	32.2	29.7	.056	.281	.412	.279	.210	.216
1974	62.8	66.9	62.1	30.0	31.6	29.7	.057	.288	.419	.270	.209	.213
1975	65.3	65.2	63.1	31.2	32.1	30.9	.064	.298	.427	.260	.205	.208
1976	60.7	65.8	61.1	28.1	31.4	28.0	.074	.303	.429	.258	.203	.205
Net Δ 1969-76	+16.1	+7.7	+2.0	+14.7	-1.6	-9.4	+105.6	+21.7	+8.6	-22.3	-17.1	-16.7

Table VI-4, (cont'd)

	Total MD Supply			Surgical Fees			Surgical Fees (Adj.)			Surgical Expenditures p.c.		
	Low	Average	High	Low	Average	High	Low	Average	High	Low	Average	High
1969	0.45	1.04	1.72	$258	$275	$299	$291	$291	$297	$15.2	$17.6	$17.9
1970	0.44	1.04	1.72	286	323	363	304	321	339	15.5	19.5	21.0
1971	0.45	1.07	1.77	308	341	401	322	330	364	19.2	19.8	21.5
1972	0.45	1.10	1.77	324	360	429	326	333	374	18.5	20.6	22.2
1973	0.42	1.16	1.78	337	379	455	307	319	361	19.2	20.5	22.1
1974	0.42	1.17	1.82	356	397	477	284	295	333	17.8	19.7	20.5
1975	0.43	1.22	1.83	382	425	523	285	291	347	18.6	18.9	21.6
1976	0.44	1.23	1.88	414	464	563	293	307	345	17.7	20.2	20.7
Net Δ 1969-76	-2.2	+18.3	+9.3	+60.5	+68.7	+88.3	+0.7	+5.5	+16.2	+16.4	+14.8	+15.6

time-series in areas of higher surgeon density, a paradox consistent with our other descriptive findings. Real fees increased over 16 percent, compared with less than one percent in the low SURGPOP areas.

The three SURGPOP groups described above constitute fairly large categories. In order to examine cross-sectional differences in utilization and fees as a function of surgeon density more closely, the 1976 PSUs were grouped in quantiles: those with surgeon-population ratios falling below the fifth percentile, between the fifth and twenty-fifth percentiles, 25-50, 50-75, 75-95, and 95%$^{+}$. Mean utilization, fee, and supply characteristics are shown in Table VI-5 for each of these quantiles. The trend across quantiles is generally as expected. PSUs in the lowest quantile (SURGPOP less than 0.05, or fewer than one surgeon for every 20,000 persons) experienced significantly lower surgical utilization rates. This appears to be a critical threshold for access to care, as utilization rates do not continue to increase with increasing surgeon density. Access may be particularly restricted for one-half of the PSUs in this group who have no local surgeons at all; we examine this directly in the following section.

There is greater variation across quantiles for the remaining characteristics. Surgeon workloads fall steadily with surgeon density from 900 operations annually to 100, while cost-of-living adjusted fees increase. Because nonsurgeons also may perform operations, these workload estimates may be biased upwards for the lower quantiles, and downwards for the upper quantiles. Using an alternative definition of workload (operations per patient care physician), however, we still observe the same trend; workloads fall from 180 on average for the lowest quantile to 26 for the highest. This suggests that surgery represents a greater proportion of total physician activity in low SURGPOP areas, while in high SURGPOP areas (which also tend to have higher

TABLE VI-5:

MEAN UTILIZATION, FEE, AND SUPPLY CHARACTERISTICS BY SURGEON-POPULATION QUANTILES

(ranges in parentheses)

	0-5 (36)	5-25 (51)	25-50 (88)	50-75 (87)	75-95 (70)	95 + (17)
Operations per 1,000	53.89 (16, 114)	64.99 (16, 105)	63.66 (19, 153)	66.60 (11, 132)	64.33 (21, 143)	55.86 (39, 107)
Elective Operations per 1,000	23.97 (0, 56)	30.55 (0, 67)	31.05 (5, 81)	30.98 (0, 86)	30.72 (6, 2)	24.86 (7, 3)
Annual Operative Workload	923.84 (0, 4820)	645.73 (127, 1583)	278.01 (76, 683)	199.61 (31, 448)	152.62 (49, 306)	100.46 (63, 208)
Surgical Fee Index	$293.66 (253, 373)	$290.38 (237, 393)	$294.20 (232, 515)	$311.84 (227, 515)	$308.52 (243, 515)	$305.87 (253, 410)
Surgeons per 1,000	0.02 (.0, .05)	0.11 (.05, .17)	0.24 (.17, .29)	0.34 (.30, .38)	0.42 (.38, .48)	0.57 (.48, .75)
GPs per 1,000	0.27	0.25	0.23	0.20	0.20	0.22
Total Patient Care MDs per 1,000	0.36	0.50	0.85	1.23	1.56	2.77
Surgical Expenditures per capita	$15.69	$18.72	$18.52	$20.81	$19.77	$16.80
Proportion Living in SMSA	0.0	0.04	0.35	0.72	0.81	0.71

concentrations of medical specialists), physicians are doing many other things besides surgery.

Findings for the top five percent are somewhat anomalous as surgery rates are actually lower than those in less surgeon-dense areas. Due to the small sample size, these differences may not be statistically significant. In addition, they may be attributed in part to the fact that almost one-third of these PSUs (5) are located in non-SMSA areas with traditionally low surgical demand (see Table VI-6). Of course, non-metropolitan PSUs with surgeon-population ratios exceeding 0.48 are themselves somewhat anomalous; examination of these areas showed that, because of their small populations, the addition of a single surgeon has an inordinate effect on the surgeon-population ratio.

As expected, PSUs with low surgeon-population ratios are generally non-metropolitan areas, more frequently in the Great Plains and Southern portions of the country. By contrast, high surgeon density PSUs tend to be large SMSAs (500,000 population and more), and to be located on either coast.

Access to Care in Surgeon Shortage Areas

What happens to people living in communities with no surgeons at all? Do they undergo operations at lower rates than people in other communities? Table VI-7 presents age and sex-adjusted surgery rates for surgeon shortage areas (SURGPOP = 0) and for nonmetropolitan PSUs with at least one surgeon (SURGPOP > 0). The variability in rates for the surgeon shortage areas can be attributed to the small sample size of this group, and their declining number over time. (The number of PSUs with no surgeons fell from 41 in 1969 to 18 in 1976.) As expected, both total and elective surgery rates are definitely lower in the shortage areas than those in other rural PSUs. But after

TABLE VI-6:

DISTRIBUTION OF SURGEON-POPULATION QUANTILES ACROSS LARGE, SMALL, AND NON-METROPOLITAN AREAS*

(percentage distributions)

	Non-Metropolitan	Small Metropolitan	Large Metropolitan
0-5	100 / 19.6	0 / 0	0 / 0
5-25	96.0 / 26.6	3.9 / 2.1	0 / 0
25-50	64.8 / 31.0	28.4 / 25.8	6.8 / 8.8
50-75	27.6 / 13.0	40.2 / 36.1	32.2 / 41.2
75-95	18.6 / 7.1	37.1 / 26.8	44.3 / 45.6
95+	29.4 / 2.7	52.9 / 9.3	17.6 / 4.4

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*Percentages to the left of the slash (/) sum to 100% within each row. Percentages to the right sum by column.

TABLE VI-7:

SURGICAL UTILIZATION IN SURGEON SHORTAGE AREAS

	Shortage Areas			Other Rural Areas		
	Total	Non-Elective	Elective	Total	Non-Elective	Elective
1969	46.5	27.9	18.6	57.2	27.8	29.4
1970	50.5	28.7	21.8	57.7	27.1	30.6
1971	60.6	35.0	25.6	59.2	28.6	30.6
1972	56.2	28.4	27.8	58.0	28.5	29.5
1973	55.9	29.9	26.0	61.9	31.5	30.4
1974	55.8	32.2	23.6	65.6	34.7	30.9
1975	63.3	28.9	34.4	64.7	34.1	30.6
1976	49.4	26.4	23.0	65.3	34.0	31.3
Average	54.8	29.7	25.1	61.2	30.8	30.4
%Δ	+6.2	+6.5	+23.7	+7.0	+10.8	+3.4

separating the nonelective and elective components of total surgery,* however, we find that there are no differences in access to necessary (i.e., non-elective) surgery. Discretionary surgery rates, on the other hand, are 17 percent lower in PSUs with no surgeons.

Since surgery rates in shortage areas are definitely positive, residents must be obtaining care somewhere. The very large increase in elective surgery rates in these areas (24%) also suggests that access to care has been enhanced over time. There are two alternative sources for surgical services: local GPs, and surgeons in neighboring SMSAs. Shortage areas do, in fact, have disproportionately more GPs per capita, providing at least some surgical care within the PSU. In addition, residents probably cross into nearby SMSAs for care. Compared with other rural PSUs, the shortage areas were more likely to be adjacent to SMSAs with: (a) larger concentrations of surgeons and/or (b) a medical school. Higher travel costs associated with obtaining care may be one factor explaining the lower utilization rates for discretionary procedures in shortage areas.

Why have no surgeons chosen to locate in these areas? Lower demand is undoubtedly one reason. Surgical fees are only slightly less in shortage areas,** but family incomes are over 10 percent lower ($8692 versus $9664 in other rural areas). Probably most important is the relative lack of hospital beds which are a necessary complement to surgical activity: shortage areas have only 3.1 beds per 1,000 compared with 4.3 beds in other nonmetropolitan

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*Subtracting the average (over eight years) elective rate from the total rate for each area yields a nonelective rate of 29.7 (54.8-25.1) operations in the shortage areas and 30.8 (61.2-30.4) for the other rural areas.

**In all instances, our surgical fee index has been based on Medicare prevailing charges which in turn are constructed from surgeons' usual and customary charges for a set of procedures. How can we then have fees for areas that have no surgeons? Prevailing charges are established by each Medicare carrier for given geographic localities. In most instances, all rural counties in a state are considered a single locality for reimbursement purposes. Prevailings would then be established based on surgeons' charges across all of these counties.

PSUs. The net effects of these exogenous variables will be shown in the econometrics chapter, when we estimate a surgeon location equation for the nonmetropolitan subsample alone.

Are these surgeon shortage areas a matter of serious policy concern? Should all of them have at least one surgeon? Our data suggest that they soon will anyway; the large production of surgeons over the last decade has led to a trickle-down into these rural areas, with the number of PSUs without surgeons falling even during our short time-series. In any event, it does not appear that access to care has been seriously compromised in these areas. Surgical services appear readily available in nearby SMSAs, and as a result we observe no differences in utilization for nonelective procedures. Although elective rates remain well below those in other rural areas, furthermore, our time-series data suggest that even this "gap" is being closed rapidly.

A Tale of Twelve Cities

As shown earlier, wide variation exists across large, small, and non-metropolitan areas, and across high, average, and low SURGPOP areas. Many of these findings were consistent with the conventional wisdom: compared with rural areas, for example, large metropolitan areas were distinguished by higher fees and higher concentrations of surgeons. Contrary to expectation, these large cities did not exhibit higher surgery rates. This may be because these cities themselves vary considerably in their demand and supply characteristics.

Table VI-8 presents selected attributes for the twelve largest SMSAs in 1976. Although all of these cities have surgeon-population ratios well above the national average, they exhibit a surprising range in age-adjusted surgical utilization, from 47 to 92 operations per 1,000 population. Nominal surgical

Table VI-8:

A TALE OF TWELVE CITIES

	Baltimore	Boston	Chicago	Detroit	Houston	Los Angeles	New York City	Phila-delphia	Pittsburgh	St. Louis	S.F.	Wash., D.C.
Total Operations	56	67	63	80	92	62	47	59	75	71	53	71
Elective Operations	26	30	29	35	48	27	24	28	40	40	25	28
Surgeon Supply	0.39	0.39	0.32	0.31	0.36	0.44	.39	0.33	0.34	0.35	0.52	0.40
GP Supply	0.15	0.17	0.21	0.12	0.20	0.29	0.20	0.19	0.20	0.12	0.23	0.15
Total MDs	2.03	1.87	1.65	1.40	1.51	1.90	2.31	1.76	1.52	1.51	2.26	1.90
Surgical Fees	$470	$467	$537	$438	$543	$762	$792	$472	$470	$450	$657	$529
Surgical Fees (adj.)	$293	$243	$327	$267	$165	$479	$423	$282	$305	$290	$395	$315
Annual Workload	143	173	196	261	241	143	125	179	234	204	106	170
Surgical Expenditures p.c. (adj.)	$16.42	$16.22	$20.50	$21.32	$33.58	$29.78	$19.85	$16.80	$22.92	$20.60	$20.49	$32.34
Family Income (adj.)	$12,820	$8,88	$14,112	$11,944	$18,663	$12,922	$10,293	$10,847	$11,717	$8,938	$14,017	$13,918
Hospital Coverage	79%	99%	56%	81%	33%	79%	83%	69%	78%	63%	80%	99%
Bed-Disability Days p.c.	0.26	0.26	0.27	0.30	0.26	0.34	0.26	0.32	0.24	0.35	0.32	0.25
Hospital Bed Supply	4.2	4.6	5.1	4.3	5.5	4.9	4.9	4.5	5.4	6.0	4.6	4.0

fees show a similar variation, with Los Angeles surgeons charging 63 percent more on average than those in Boston. Adjustment for cost-of living differences actually widens the earnings gap; Los Angeles surgeons, for example, charge fees double those of their Boston colleagues. Although operative workloads are twice as heavy in some cities compared to others, all of these workloads are still well below the national mean of 268 per annum.

These twelve cities also exhibit considerable variation in exogenous demand and supply factors, some of which are shown in Table VI-8. Differences in family income and insurance coverage, hospital bed supply, and health status (as measured by bed disability days) suggest that at least part of the variation in surgery rates and fees is due to these factors, and not just to the supply of surgeons. Cities with higher surgical utilization and higher fees tend to have more hospital beds per capita, higher incomes or greater insurance coverage, and a somewhat sicker population.

Finally, it is worth noting that the cities with relatively more surgeons are also those popularly perceived as "nice places to live", e.g., San Francisco, Los Angeles. This is consistent with other evidence that "taste" or residential amenity factors play an important role in surgeon location.

VII. ECONOMETRIC RESULTS

Empirical Specification

The theory presented in Chapter IV, constrained by available data, led to the following, simplified model of the physician market:

(7.1) $SR = f_1\ (p, SP, Y)$: per capita surgery demand

(7.2) $W = f_2\ (p, SP, N)$: surgeon workloads

(7.3) $SS \equiv SP \cdot W$: surgery supply per capita

(7.4) $SP = f_3\ (p, W, A, N)$: surgeon location

(7.5) $SR = SS \equiv SP \cdot W$: demand = supply equilibrium condition

Solving (7.5) for the equilibrium price ($\bar{p}$) we have:

(7.5a) $f_1\ (\bar{p}, SP, Y) = f_2\ (\bar{p}, SP, Y, N) \cdot SP$

or

(7.5b) $\bar{p} = f_4\ (SP, Y, N).$

where SP = per capita surgery rate; p = average surgical fees; SP = surgeon-population ratio; Y = vector of relevant demand characteristics; W = surgeon workloads (i.e., average operations per surgeon),* SS = surgery supply

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*W is not surgical workloads of surgeons, strictly speaking, but something more. Calculated as the ratio of per capita surgery to surgeons per capita,

$$W = W_s + W_o \cdot \frac{OP}{SP}.$$

where W_s = true surgeon surgical workloads, W_o = non-surgeon surgical workloads, and OP/SP = ratio of other-to-surgeon supplies per capita. Neither W_s nor W_o are observable. Operative surgeon workloads are:

$$W_s = W - W_o \cdot \frac{OP}{SP}$$

Where $W_o = 0$, $W_s = W$ (presumably OP is always positive except in those rare instances in which a PSU is served only by one surgeon). Where W_o is positive, operative workloads of surgeons will actually be less than W as nonsurgeons perform some of the surgery. Changes in W may not by truly representative of changes in W_s, either, as nonsurgeon operative workloads may also be changing. Finally, Ramsey (1980) reminds us that W is, more accurately, output per surgeon (including nonphysician inputs). This distinction seems less important here as little auxiliary substitution for surgeon input is possible.

per capita; N = vector of cost and productivity-influencing variables; and A = vector of professional and community amenities.

Equations (7.1-4) and (7.5b) represent four structural equations and an identity, with five endogenous variables and several exogenous ones. Lack of information on physician hours of work and input use prevented a more elaborate model incorporating production functions, factor demands, and physician effort. The influence of these endogenous variables are embedded in the workload and location equations.

Inducement theory presumes physicians have some discretionary influence over demand; hence the unorthodox inclusion of the surgeon-population ratio in the demand equation. A significant, positive coefficient for SP in eq. (7.1) would corroborate earlier work by Fuchs (1978) that surgeons can, and systematically do, shift demand when faced with increasing competition. Because supply may be particularly inelastic, demand shift may manifest itself, not so much in increased utilization, as in higher equilibrium fees. Two alternative tests are therefore conducted: one involves re-estimating the structural demand equation with fees on the left-hand-side, while the second estimates the equilibrium price equation (7.5b), incorporating both (hypothesized) positive demand and negative SP supply effects.

Endogenous Variables

Endogenous variables include surgery rates, surgeon-population ratios, workloads, and average surgeon fees. Variable definitions, means, and standard deviations are presented in Table VII-1.

Surgery Rates: Surgery rates were specified in three alternative ways. Structural demand equations were estimated using all specifications. First, we examined total surgical operations per 1,000 population (SR). (Obstetric procedures were excluded, since they are dependent on conception and birth

TABLE VII-1:

VARIABLE DEFINITIONS, MEANS, AND STANDARD DEVIATIONS

Variable	Description	Mean	S.D.
SR	total operations per 1,000 population	62.18	17.98
SRN	nonelective operations per 1,000 population	31.23	12.64
SRE	elective operations per 1,000 population	30.95	11.44
SP	surgeons per 1,000 population	0.30	0.13
W	annual operative workload	280.76	471.29
P	surgical fee index, COL adjusted	323.39	61.59
ELDPC	proportion 65 years and older	0.10	0.04
MIDPC	proportion aged 45-64 years	0.21	0.04
YAPC	proportion aged 21-44 years	0.44	0.05
F	proportion female	0.52	0.02
WHITE	proportion white	0.87	0.12
EDHS	proportion 9-12 years education (household heads)	0.47	0.08
EDCL	proportion 13 years education and more (household heads)	0.28	0.11
DISPC	mean bed disability days	0.25	0.10
INC	mean family income (in 1,000s), adj.	10.7	2.36
COIN	proportion of hospital expenses covered by third party payors	0.84	0.30
HEXPA	hospital expenses per admission in (100s), adj.	10.85	12.08
EMP	proportion employed	0.58	0.06
PROF	professional and technical workers, managers (proportion of labor force)	0.26	0.07

TABLE VII-1: Cont'd

VARIABLE DEFINITIONS, MEANS, AND STANDARD DEVIATIONS

Variable	Description	Mean	S.D.
CLERK	clerical, sales, and service workers (proportion of labor force)	0.35	0.07
BLUEC	craftsman, operatives, and laborers (proportion of labor force)	0.34	0.09
GPPC	general practitioners per 1,000 population	0.23	0.07
NSP	surgeons in adjacent SMSA per 1,000 population in non-SMSA and adjacent SMSA	0.04	0.10
BEDPC	short-term general hospital beds per 1,000 population	4.55	1.76
WAGE	hourly wage for employees in retail trade, adj.	2.18	0.73
SMSA	proportion residing in SMSA	0.67	0.46
DEGD	degree days (in thousands)	4.46	1.92
COLLG	number of colleges and universities	9.01	12.68
HOTLPC	hotel receipts (in thousands) per capita, adj.	0.05	0.09
TIME	time trend	4.39	2.27

rates and not of analytic interest.) Then, we decomposed SR into nonelective (SRN) and elective operations (SRE) per 1,000 population based on the criteria described earlier in Chapter V. Elective operations included cholecystectomy, tonsillectomy, varicose vein excision, and hemmorhoidectomy, among others. Surgeons are hypothesized to have greater discretionary influence over elective procedures, and thus the rates of these procedures are expected to be more sensitive to inducement than operations for life-threatening conditions. These rates were not age and sex-adjusted; instead age and sex were included as exogenous right-hand variables.

Surgeon-Population Ratio: The relative concentration of surgeons in a market area was measured by the surgeon-population ratio (SP): the number of office-based surgical specialists per 1,000 PSU population.

Workloads: Surgical workloads were defined as average annual number of operations per surgeon. Surgeon-specific workload data were not available; instead, W was calculated as the ratio, SR/SP.

Surgical Fees: The gross price of surgical services was measured by a surgical fee index. Ideally, we would have liked to calculate both a gross and a net price variable, adjusted by the appropriate coinsurance rate. Unfortunately, coinsurance data for surgical services *per se* were unavailable. As surgical insurance coverage is almost perfectly correlated with hospitalization coverage (which we did measure), the lack of an out-of-pocket surgeon's price is probably not a serious problem.

Medicare prevailing charges for a mix of surgical procedures were used to proxy the surgeon's usual fees in the preceding year. Fee data were consistently available for six relatively common operations: cholecystectomy, hemmorhoidectomy, hernia repair, lens extraction, prostatectomy, and radical mastectomy. The surgical fee variable (P) is a weighted fee index of the six procedures, using the national frequency of these operations as weights. This has the effect of holding constant inter-regional variations in fees due to differences in surgical mix -- an important consideration in comparing urban and rural areas. Medicare also calculates "prevailings" for both surgeons and nonsurgeons separately. To avoid confounding fee differences with surgeon-nonsurgeon mix, the index was based on surgeons' fees alone.

Exogenous Variables

Exogenous variables included the Y, N and A variables in the structural equations presented above. The Y vector consisted of demand variables, including sociodemographic characteristics of the population, health status, ability to pay, the price of hospital care, and substitute sources of care. The N vector represented cost and productivity-influencing variables. The A variables consisted of professional and residential amenities of a community that influence the surgeon's location decision. Finally, a time variable was added to capture systematic changes over time that may be correlated with the exogenous variables.

Socio-demographic Characteristics: Socio-demographic characteristics included age, sex, race, and education, defined for the PSU. Three age variables were specified: the proportion of PSU population 65 years and older (ELDPC), 45-64 years (MIDPC), and 21-44 years (YAPC). The youngest age group constituted the omitted category in the intercept. Sex and race were defined as the proportion female (F) and white (WHITE), respectively. Older persons, women, and whites are hypothesized to raise the demand for surgery, *ceteris paribus*. Education was measured as the proportion of household heads in a PSU having completed 9-12 years of schooling (EDHS) and 13 years plus (EDCL). (The omitted category included heads with less than 9 years of education). Education of the household head is more appropriate here as the parent or other breadwinner is assumed to make health care decisions for the family as a whole. Highly educated persons are hypothesized to be more knowledgeable about the value of preventive health care, better able to maintain their stock of health, and hence require fewer surgical services. Education is hypothesized to be inversely related with surgery rates for this reason, holding income and health insurance coverage constant. Better educated persons also may be less susceptible to inducement by surgeons and thus experience even lower rates for elective surgical procedures (the Pauly-Satterthwaite (1980) argument).

Health Status: The health status of the potential patient population was measured by the mean number of bed-disability days reported in the PSU over a two-week period (DISPC). A bed-disability day is one in which the respondent stayed in bed because of a specific illness or injury, and thus was unable to perform his usual activities, e.g., work, school, etc. Surgery rates are hypothesized to be positively related to bed disability days.

Ability to Pay: Two variables measure ability to pay: income and health insurance coverage. Income was defined as mean family income in the PSU (INC). Unfortunately, it was not possible to distinguish between earned and unearned income, and we can not determine the net effect of this variable on demand *a priori*.

Health insurance coverage was defined as the proportion of hospital expenses covered by all third party payors and is hypothesized to raise the demand for surgical operations. Reliable health insurance data were not available from HIS; instead, the COIN variable was derived for each PSU from a state insurance regression. (See Appendix A.)

Price of Hospital Care: The price of surgery included three components: the price of surgical services (the endogenous variable, P, discussed above), the price of hospitalization, and patients' time price. The gross price of hospitalization (HEXPA) was measured by mean hospital expenses per admission in a PSU. (Hospital prices were assumed exogenous to surgery rates.) The HEXPA variable was constructed across all short-term general hospitals in a PSU, and weighted by each hospital's share of total PSU admissions.

With low coinsurance rates, the time price of surgery becomes a large proportion of the total price. Ideally, we would measure time price by the respondent's wage rate. Wage data were unavailable, however, so instead we used the PSU occupation distribution and employment status as proxy measures. EMP was defined as the proportion of PSU population who were working at the time of interview. Three occupational variables were specified: the proportion of the labor force composed of professional and technical workers, and managers (PROF), the proportion clerical, sales, and service related workers (CLERK); and the proportion craftsmen, operatives, and laborers (BLUEC). Farm workers and farm managers constituted the omitted group. In areas of high employment and more highly paid occupations, i.e. where average time prices are high, surgery rates should be lower, _ceteris paribus_. The coefficients for the employment variables are hypothesized to be larger in the discretionary surgery equations, as employed persons demand relatively fewer elective procedures.

Substitute Sources for Care: The relative supply of general practitioners constitutes a potential source for non-surgical care and was defined as the number of GPs per 1,000 PSU population (GPPC). For those non-metropolitan PSUs where border-crossing appeared likely, an additional surgeon variable was specified. NSP was defined as the number of surgeons in the adjacent SMSA per 1,000 population, where the population included the SMSA plus rural PSU resident population.

Cost/Productivity Variables: The N vector was limited to two complementary input variables: hospital beds and nonphysician wages. BEDPC was defined as the number of short-term general hospital beds per 1000 and is hypothesized to increase the supply of surgical operations, ceteris paribus, by improving access. Surgeons are also hypothesized to restrict supply, or require higher fees, where the costs of labor inputs are higher. WAGE was defined as the mean hourly wage rate for persons employed in retail trade.

Professional Amenities: Surgeons are expected to practice in areas where they can enjoy certain professional and residential amenities, inter alia. Professional amenities included two measures: urbanization and proximity to a medical school. Urbanization (SMSA) was defined as the proportion of PSU population residing in an SMSA. Surgeons have been hypothesized to locate near medical schools where they would have access to the most up-to-date medical technology. Proximity to a medical school (measured as the number of medical schools in the PSU) was highly colinear with the presence of colleges, however, and as the latter was a superior predictor, medical schools were dropped from the surgeon location equation.

Residential Amenities: Four variables measured the attractiveness of a PSU as a place to live: racial mix of the community (WHITE), climate, cultural opportunities, and its attractiveness as a vacation spot. The climate variable (DEGDAYS) was defined as annual degree days, or the number of days the temperature falls below 65°F. times the number of degrees below 65. Surgeons are hypothesized to avoid colder climates , as measured by higher degree days. Cultural opportunities were proxied by COLLG, the absolute number of colleges and universities in the PSU. Finally, PSUs with a high hotel and motel volume were assumed to be attractive vacation spots; HOTLPC was specified as hotel receipts per capita.

Time: Finally, a linear time trend was included to capture secular trends in the demand for, or supply of, surgical services (TIME). Patient attitudes toward surgery may change systematically over time, for example, or innovations in medical technology may alter accepted surgical practice.

Estimation Methods

The structural model was estimated in linear* form using two-stage least squares on a sample of 349-360 PSUs over the eight year period, 1969-76, for a total sample of 2,837. Each year represented an independent national probability sample with slightly different numbers of PSU observations in each period. This prevented estimation of dynamic, lagged adjustment models although a modified disequilibrium approach was taken to test the single period equilibrium assumption. Because of the presence of simultaneous equation bias, all endogenous variables, SR, SRN, SRE, P, SP, W, were first regressed on the complete list of exogenous variables as instrumental variables. Their imputed values were then used in estimating structural coefficients in the second stage. All regressions were weighted using PSU population weights.

Empirical Results

Empirical results are presented in four sections. The first section examines some of the regression equations in reduced form. The second set of two-stage results is based on the (usual) assumption of prices adjusting within each year to clear markets (eq. (7.5) above). Equilibrium results are presented first for the sample as a whole and then for non-metropolitan, small, and large metropolitan areas separately. The third section considers the possibility of quasi-rigid prices leading to chronic surgeon surplus and shortage areas. A final section summarizes the findings and considers their plausibility in light of the major criticisms of previous research.

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*Multiplicative forms were tried as well with little difference in the main results. One real disadvantage in taking logs for this work is the significant number of PSUs without surgeons that must be dropped.

Reduced Form Equations

Although this chapter focusses on the second-stage regression estimates, some of the first-stage equations are of interest in their own right. The reduced-form surgery rate equations, for example, allow us to examine the exogenous demand and supply factors influencing small area variations in surgical utilization. In addition, we are interested in the factors influencing surgeon location over time. Table VII-2 presents the results for four of the first-stage equations: total surgery per 1000 (SR), nonelective surgery per 1000 (SRN), elective surgery per 1000 (SRE), and surgeon location (SP). Both regression coefficients and standardized beta weights are provided, separated by a slash. Beta weights permit a direct comparison of utilization differences due to the explanatory variables. The low R^2s suggest that much of the variation in surgery rates remains unexplained; nevertheless, many of the variables are significant and in the predicted direction. The surgeon location equation is highly significant, on the other hand, explaining 68 percent of the variation in surgeon distribution across PSUs.

Surgery Rates: The age and sex composition of a community does influence surgical utilization, with elderly (ELDPC) and middle-aged (MIDPC) persons demanding significantly more operations than younger age-groups. A doubling of the proportion elderly in a community raises surgery rates by eight percent or 5 operations per 1,000. Due to the attendant surgical risks, it was hypothesized that older persons would demand fewer discretionary procedures, and as we see in eq. (3), there are no age differences in elective rates.

Table VII-2:

REDUCED-FORM (FIRST STAGE) REGRESSION EQUATIONS: ENTIRE PSU SAMPLE, 1969-1976

INDEPENDENT VARIABLE	DEPENDENT VARIABLES			
	SR (1) Coeff./Beta	SRN (2) Coeff./Beta	SRE (3) Coeff./Beta	SP (4) Coeff./Beta
ELDPC	51.4/.115**	44.4/.141**	6.9/.014	0.308/.085**
MIDPC	23.2/.048*	27.3/.086**	-4.1/.013	0.185/.053**
YAPC	14.4/.037	7.5/.012	6.9/.028	0.162/.057**
F	-5.3/.007	-24.1/.038**	18.8/.040**	0.116/.021*
WHITE	10.1/.076**	1.5/.014	8.6/.090**	0.033/.030**
EDHS	23.6/.101**	10.2/.065**	13.4/.090**	0.163/.097**
EDCL	6.7/.041	7.2/.063	-0.5/.005	0.374/.314**
DISPC	19.6/.111**	14.2/.112**	5.4/.048**	-0.015/.012
INC (000)	0.47/.062**	0.37/.069**	0.09/.019	0.001/.013
COIN	1.47/.025	1.01/.024	0.47/.012	0.009/.021
HEXPA (00)	-0.19/.128**	-0.10/.093**	-0.09/.100**	-0.0003/.028*
EMP	3.0/.001	5.4/.023	-2.4/.012	0.103/.047**
PROF	6.7/.025	-0.7/.004	7.4/.043	0.263/.136**
CLERK	18.3/.068**	4.5/.025	13.8/.081**	0.290/.149**
BLUEC	15.7/.077**	4.5/.032	11.3/.087**	0.223/.151**
GPPC	-18.4/.076**	-7.1/.039*	-11.3/.073**	-0.288/.164**
NSP	-0.1/.001	-1.5/.012	1.4/.013	-0.153/.121**

Table VII-2, cont'd:

INDEPENDENT VARIABLE	DEPENDENT VARIABLES			
	SR (1) Coeff./Beta	SRN (2) Coeff./Beta	SRE (3) Coeff./Beta	SP (4) Coeff./Beta
BEDPC	0.37/.036*	0.07/.010	0.31/.045**	0.023/.311**
WAGE	-0.2/.008	0.27/.016	-0.5/.032*	0.006/.034**
SMSA	2.5/.064*	1.4/.051	1.2/.048	0.057/.202**
DEGDAYS (000)	0.2/.021	0.1/.015	0.1/.015	-0.010/.148**
COLLG	-0.10/.071**	-0.09/.090**	-0.01/.011	0.001/.098**
HOTLPC	6.2/.031*	4.8/.034	1.4/.011	0.037/.026**
TIME	0.30/.038*	0.55/.099**	-0.25/.050**	-0.005/.087**
CONST	2.1	6.4	-4.2	-0.449**
R^2	.09	.09	.05	.68
(F)	(12.1)	(11.4)	(6.5)	(252.1)

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* Significant at ten percent level.
**Significant at five percent level.

NCHS Hospital Discharge Survey data have shown that women have higher surgical utilization rates, even after excluding obstetrical procedures and adjusting for age differences (NCHS, unpub.). Yet, our HIS results indicate comparable total surgery rates for both men and women, once other factors such as health status are held constant (eq. 1). Once we decompose total surgery rates, however, we observe that higher demand by women for discretionary operations (eq. 3) is almost perfectly offset by their lower demand for nonelective procedures (eq. 2). This probably reflects the large number of gynecologic procedures included in our definition of elective surgery. It is also consistent with McCarthy and Finkel (1980) who have suggested that male-female differences in surgical utilization are almost wholly due to such sex-specific procedures.

Previous research has indicated that after adjusting for family income, no differences remain in surgical utilization between whites and nonwhites (Bombardier _et al._, 1977). Our data confirm this finding, but only for nonelective surgery. Whites demand significantly more discretionary procedures, holding constant not only income but also other important demand variables such as health status. Eq. (3) implies that communities with a population 95 percent white will experience 1.7 additional elective operations per 1000 (around a mean of 31), compared with areas only 75 percent white. These differences may reflect ethnic differences in attitudes toward surgery, or (more disturbingly) inequalities in access to medical care.

Household heads with 9-12 years of schooling (EDHS) demand significantly more operations (both elective and non-elective) than do those with either more or less education, a finding consistent with earlier work. Bombardier _et al._, (1977) have suggested that the higher education group may have better ambulatory insurance coverage that facilitates non-surgical treatment. (Our insurance variable measures coverage for hospitalization only.) This group also may be more knowledgeable about preventive medical care, and hence enjoy better health status (Grossman, 1972). Pauly has hypothesized that more highly educated persons might be less sensitive to inducement, and thus experience lower surgery rates (in Fuchs, 1978). If this is true, then why are surgery rates lower in areas with fewer high school graduates?

Underlying illness characteristics make a significant contribution to small area surgical variation.* In fact, the DISPC variable is one of the most important factors in explaining the variance in total operative rates, as measured by its beta weight. Communities with poorer health status, as measured by more bed-disability days per capita, experience higher surgery rates, ceteris paribus. The DISPC coefficient is positive and significant in the elective surgery equation, but its associated elasticity is less than one-half the size of the corresponding elasticity for nonelective surgery (eq. 2). This is not unexpected, as discretionary surgical procedures are more likely to be associated with less serious illnesses.

Much less expected is the key role economic variables play in explaining small area variations in surgery rates. The magnitude of the standardized regression coefficients (betas) for INC and HEXPA in particular suggest that limited ability to pay and high hospital prices continue to reduce access to surgical services. Indeed, high hospitalization costs are the single most important factor in explaining surgical rate variation, according to its beta weight (= .13 in eq. 1), higher even than health status, age, or sex. Why hospital insurance coverage (COIN) is not significant in any of the utilization equations may be attributed to the lack of inter-PSU variation in this variable.

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*Surgery, of course, is itself disabling over a postoperative convalescent period, but this is not the causal direction being observed here. DISPC measures bed-disability days over a two-week period only, while surgical rates are based on a twelve-month period.

The occupational measures of time price apparently affect only the demand for elective surgery. Clerical and blue collar workers demand more discretionary operations, compared with agricultural workers, probably because their wages are protected by sick leave benefits which lower the real time price of surgery. The PROF coefficient, while positive, is insignificant, possibly due to offsetting effects, e.g., higher time prices confounded with superior ambulatory insurance coverage.

The GP-population ratio may make two offsetting contributions to surgical rate variation. First, GPs may substitute for surgeons in performing operations, and GPPC may be positively correlated with surgery rates. Second, if GPs provide alternative non-surgical treatment for certain medical conditions, then surgery rates may be lower. As seen in Table VII-2, the latter effect clearly dominates. Surgery rates, both elective and non-elective, are significantly lower in areas with higher concentrations of GPs. A ten percent increase in the supply of GPs per 1000 population results in a 0.8 percentage decrease in the elective surgery rate, or 0.3 operations per year (around a mean of 31) ceteris paribus.*

Exogenous supply variables include those influencing costs, productivity, and surgeon location. Enhanced productivity encourages discretionary operations, but has no impact on nonelective procedures. Elective surgery rates are significantly higher where hospital beds are more plentiful (BEDPC), even after adjusting for health status, age, and sex. The surgeon is more productive where there are not long queues for non-emergency hospital admissions. Elective surgery rates are also somewhat higher when practice costs are lower, as measured by lower wages for nonphysician personnel (WAGE). Surgical utilization is also higher in those areas that surgeons like to live in, as measured by the positive SMSA and HOTLPC coefficients in eq. (1). Two other variables influencing surgeon locational choice (COLLG and DEGDAYS) are generally insignificant.

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*These reduced-form estimates may provide an overestimate of the GP effect, as the endogenous SP variable is not held constant here (although exogenous surgeon location variables are included). As seen in the descriptive results, GP supplies are inversely correlated with, and probably causally related to, the number of surgeons.

The coefficient for the time trend in eq. (1) implies a net increase of 0.3 surgeries per 1000 per annum (around a mean of 62) holding time-related changes in income, insurance, population health and age distribution, physician supplies, etc., constant. A larger increase in nonelective surgery is offset to a fair degree by a decline in elective utilization. That the sign of this time trend (eq. 3) is negative and significant is quite unexpected. If the time trend represents true technological change, purged of other demand-influencing phenomena, the negative sign may represent a switch to noninvasive treatment modalities for less traumatic symptoms. A number of the procedures included in our definition of elective surgery have, in fact, been falling over time, e.g., tonsillectomy, varicose vein excision. It has now become accepted medical practice to treat many of the underlying conditions medically rather than surgically -- definitely a positive sign.

Surgeon Location: The reduced-form surgeon location equation (eq. 4) is highly significant ($R^2 = .68$), with virtually all variables in the predicted direction. Surgeons appear to be attracted to those areas with high demand for their services, i.e., to communities that are disproportionately older, female, and white. Most important among this set of sociodemographic measures (as measured by the beta weights) are the two education variables, particularly the proportion of household heads who have attended at least some college (EDCL). A ten percent increase in the percent of heads going to college raises the surgeon-population ratio by 3.5 percent, or about one additional surgeon for every 100,000 residents. We know from eqs. (1) - (3) that college-educated heads do not demand significantly more operations. Instead, a better educated population enhances the attractiveness of a community. Surprisingly, surgeons do not appear to locate in those areas where the medical need is greatest, i.e., where per capita disability days (DISPC) are higher. Perceived variation in medical need may be captured here by the age and sex variables.

Traditional economic variables appear to be relatively unimportant in the surgeon's location decision.* Variables measuring patient ability to pay (INC and COIN) are insignificant (although in the predicted direction); most of their effect apparently is captured by the price variables. Surgeons tend to locate in areas where hospital costs are lower (HEXPA), ceteris paribus, and hence demand for surgical services higher. The cross-price elasticity is quite small, however: -0.01. All four of the occupational measures (EMP, PROF, CLERK, BLUEC) proved to be strong predictors of location. Surgeons were found to settle in areas with higher employment rates and where the share of the labor force in agricultural activites is lower. Non-agricultural (urban) areas undoubtedly are more attractive locations in which to live and work. In addition, professional, clerical and blue collar workers certainly have superior insurance coverage, thus increasing demand for new surgeons. (Our insurance variable, COIN, may be imperfectly measured.)

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*Of course, the key economic variables, surgical fees and expected workloads, were omitted from the reduced-form equation. Anticipating our two-stage results (see eq. 11), predicted workloads proved to be highly significant; surgeons locate in those areas where workloads are lighter. The predicted price variable, while positive as hypothesized, did not attain statistical significance.

Surgeons appear to locate in areas where there are fewer alternative sources of care (and thus perhaps also less competition), i.e., where the relative supply of GPs is lower (GPPC). This is consistent with the tabular work presented in the previous chapter. While this might be interpreted as an urbanization effect (GPs are far less plentiful in large cities), urbanization has been held constant by the SMSA variable. A ten percent reduction in the GP-population ratio is offset by a corresponding 2.2 percent increase in surgeon supply, approximately 0.7 additional surgeons per 100,000 population.

Surgeons were hypothesized to locate in those areas where they can expect to earn high incomes. Surgeon net incomes can be roughly decomposed into surgical fees times surgical workloads minus practice expenses. Fees and workloads can not be included in this reduced-form equation, but we do have two proxies for practice costs: the supply of hospital beds and wages for nonphysician personnel. Hospital beds constitute an important complementary input to the production of surgical services. Where beds are more plentiful, the surgeon can operate more readily (because queues for admission are shorter), and he can make greater use of free hospital inputs, such as nursing staff. We observe in eq. (4) that BEDPC is in fact the single most important predictor of surgeon location. Communities with 500 hospital beds for every 100,000 residents will attract approximately 2.5 additional surgeons (around a mean of 30), compared to areas with a relative supply of only 400 beds, *ceteris paribus*. Surgeons appear to be attracted to areas with higher wage rates, contrary to theory. The WAGE variable may be reflecting standard-of-living differences, such as greater residential amenities.

Surgeons definitely locate in areas offering social and cultural amenities, i.e., areas deemed attractive by high-income consumers. The four amenity or taste variables (SMSA, DEGDAYS, COLLG, and HOTLPC) are all important predictors of the surgeon's location decision. Surgeons gravitate toward urban centers, a finding consistent with virtually all previous research on physician distribution. Communities with 80 percent of their population residing in SMSAs will attract approximately three additional surgeons per 100,000, than communities that are only 30 percent urban, all other factors being equal. Since consumer demand, the availability of hospital beds, and social and cultural opportunities are held constant here, they do not explain this strong impact for the SMSA variable. Metropolitan areas also are characterized by lighter surgical workloads, and leisure-maximizing surgeons may locate in cities for this reason as well. We test this explicitly in the two-stage regressions below. Surgeons also seek out communities that are "nice places to live in", that offer warm weather, educational/cultural opportunities (as measured by the number of colleges and universities), and that are popular vacation spots (proxied by hotel receipts per capita).

Finally, while the descriptive findings showed that the supply of surgeons has increased dramatically over time, the time trend is actually negative. The TIME coefficient is positive and significant, however, in the two-stage results, suggesting that in this reduced-form, TIME is capturing an omitted variable that has fallen over time. Surgical workloads, for example, have decreased from 1969 to 1976; variables proxying workload were included, but may have been imperfect measures.

Equilibrium Results

The results for the entire time series of cross-sections, based on the equilibrium framework outlined above, are shown in Table VII-3. Equations (5-7) represent per capita* demand equations for total (SR), nonelective

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*Strictly speaking, per 1000 population. All coefficients relating to SR, SRN, SRE, and SP are automatically scaled per 1000 population.

TABLE VII-3:

TWO-STAGE LEAST SQUARES REGRESSIONS: ENTIRE PSU SAMPLE, 1969-1976
(t-values in parentheses)

INDEPENDENT VARIABLE	DEPENDENT VARIABLE						
	SR (5)	SRN (6)	SRE (7)	P (8)	$\bar{P}$ (9)	W (10)	SP (11)
P	-0.026 (2.1)**	-0.010 (1.09)	-0.016 (2.0)**	--	--	0.103 (0.5)	0.0002 (1.2)
SP	17.53 (2.1)**	4.50 (0.8)	13.01 (2.4)**	382.5 (3.3)**	972.7 (14.6)**	-1158.9 (8.7)**	--
W	--	--	--	--	--	--	-0.0003 (9.6)**
SR	--	--	--	-13.3 (3.5)**	--	--	--
ELDPC	46.5 (3.4)**	43.2 (4.4)**	3.3 (0.4)	547.8 (2.1)**	-255.9 (4.0)**	--	--
MIDPC	20.4 (1.6)*	26.5 (3.0)**	-6.1 (0.7)	221.4 (1.2)	-363.0 (6.0)**	--	--
YAPC	12.2 (0.9)	8.3 (0.9)	3.9 (0.4)	136.0 (0.7)	-214.8 (3.4)**	-- --	-- --
F	-5.1 (0.4)	-23.6 (2.3)**	18.5 (2.0)**	-34.7 (0.2)	-35.1 (0.5)	--	--
WHITE	10.9 (3.1)**	2.3 (0.9)	8.6 (3.8)**	82.6 (1.2)	-83.3 (5.4)**	--	--
EDHS	21.6 (3.8)**	10.2 (2.6)**	11.3 (3.1)**	201.7 (1.7)*	-250.2 (9.5)**	--	--
EDCL	0.3 (0.0)	4.7 (0.9)	-4.4 (0.9)	-30.1 (0.3)	-370.3 (9.0)**	-- --	-- --
DISPC	20.3 (5.8)**	14.5 (5.9)**	5.8 (2.6)**	316.5 (3.7)**	43.31 (2.7)**	--	--
INC (000)	0.70 (3.3)**	0.49 (3.3)**	0.21 (1.5)	15.8 (5.5)**	9.1 (11.4)**	--	--
COIN	0.40 (0.2)	0.22 (0.2)	0.17 (0.2)	27.75 (1.2)	57.5 (7.3)**	--	--
HEXPA (00)	-0.22 (6.4)**	-0.15 (6.2)**	-0.07 (3.2)**	-2.13 (2.0)**	0.78 (5.2)**	--	--
EMP	-1.9 (0.3)	3.4 (0.7)	-5.3 (1.1)	-133.1 (1.4)	-209.0 (6.6)**	--	--
PROF	-2.4 (0.2)	-4.0 (0.6)	1.6 (0.2)	-144.1 (1.1)	-437.4 (8.9)**	--	--
CLERK	10.5 (1.2)	2.4 (0.4)	8.1 (1.4)	22.8 (0.2)	-488.5 (10.7)**	--	--

TABLE VII-3, cont.

TWO-STAGE LEAST SQUARES REGRESSIONS: ENTIRE PSU SAMPLE, 1969-1976
(t-values in parentheses)

INDEPENDENT VARIABLE	SR (5)	SRN (6)	SRE (7)	P (8)	$\bar{P}$ (9)	W (10)	SP (11)
	DEPENDENT VARIABLE						
BLUEC	7.8	1.3	6.5	16.5	-372.2	--	--
	(1.2)	(0.3)	(1.4)	(0.2)	(10.1)**		
GPPC	-13.6	-6.5	-7.2	-67.8	349.2	-99.8	--
	(2.4)**	(1.6)	(1.9)**	(0.7)	(12.6)**	(0.8)	
NSP	2.3	-0.7	3.0	57.9	175.8	630.7	--
	(0.6)	(0.2)	(1.2)	(1.1)	(8.5)**	(6.6)**	
BEDPC	--	--	--	--	-22.5	-7.2	0.013
					(13.8)**	(1.2)	(5.8)**
WAGE	--	--	--	--	-0.2	-0.5	0.005
					(0.1)	(0.1)	(1.3)
SMSA	--	--	--	--	--	--	0.06
							(5.2)**
DEGDAYS (000)	--	--	--	--	--	--	-0.005
							(1.8)*
COLLG	--	--	--	--	--	--	0.0
							(0.0)
HOTLPC	--	--	--	--	--	--	-0.03
							(1.0)
TIME	0.40	0.58	-0.19	5.10	4.41	2.94	0.003
	(2.2)**	(4.6)**	(1.6)	(1.8)*	(4.9)**	(0.8)	(2.2)**
CONST	20.1	13.0	7.1	581.2	899.8	617.3	0.24
	(1.4)	(1.3)	(0.8)	(3.2)**	(13.1)**	(8.6)**	(4.1)**
R^2	.09	.08	.05	.03	.22	.14	.30
(F)	(14.0)	(13.0)	(7.6)	(4.0)	(36.9)	(65.8)	(132.9)

* Significant at ten percent level.

** Significant at five percent level.

(SRN), and elective (SRE) surgery, respectively, while equation (8) is analogous to (5) except that price and output have been interchanged. Equation (9) is a quasi-reduced-form equilibrium price equation with surgeon density the only endogenous variable. Equations (10-11) explain surgeon workloads and location, respectively.

Both the total and elective surgery demand equations show statistically significant, negative price effects, although the own price elasticities are quite small (-0.14 and -0.17, respectively). Nonelective surgery also shows a negative price effect, but it is not statistically significant. Higher gross hospital prices per admission, like physician fees, discourage elective and nonelective surgery as expected, but the cross-price elasticity is also quite small (-.04). Occupational measures of time price were generally insignificant in the demand equation, possibly due to offsetting effects (viz., higher time prices confounded with greater disability insurance , more sick leave, and health status).

Hospital coinsurance rates were not found to be significant in the utilization equations, most of their effect coming in terms of prices as discussed below. Hospitalization coverage is now quite extensive and shows very little variation (its coefficient of variation (CV) was .36) in comparison to variations in gross admission charges (CV = 1.1). The relative lack of variation is probably the main reason for its insignificant marginal effect on demand.

Other significant variables in the demand equation (5) include health status (DISPC, +), family income (INC +), time (TIME, +), middle aged and elderly per capita (MIDPC, ELDPC, +), high school graduates (EDHS, +), percent white (WHITE, +), and general practitioners per capita (GPPC, -). Their coefficients are not materially different from those in the reduced-form equations which have already been discussed in depth.

Holding fees and other relevant demand factors constant, surgeon density (SP) is significant and positive in both the total and elective (but not nonelective) demand equations. A 10 percent increase in surgeons per capita results in a 0.9 percent increase in overall surgery per capita and a 1.3 percent increase in elective surgery. The positive SP elasticity, due primarily to elective surgery, supports the hypothesis that more discretionary surgical procedures are performed in areas of high surgeon concentration.

In areas with surgeon densities one standard deviation (.13) above the mean (.30), patients "demand" 2.3 (.13 x 17.53) more operations per 1000 population per year as a result of surgeon availability alone, made up of 1.7 (.13 x 13.01) elective and 0.6 nonelective operations (see Figure VII-1). This is in addition to any increases, if any, that might derive from lower competitive fees in overserved areas. Assuming surgeons' fees, hospital admission costs, and surgical lengths of stay are uncorrelated with surgeon density,* the expected cost implication of 2.3 more operations is estimated to be $3238 (2.3 x ($323 + $1085)) per 1000 population in 1969 dollars, or the sum of average physician and hospital charges per operation times the predicted additional utilization. In a city of one million, this would translate into $3.238 million additional dollars related to "induced" surgery each year in 1969 dollars. The 88 percent increase in nominal fees in surgeon-dense areas from 1969 to 1976 (see Table VI-4) suggests that by 1976, the cost of surgeon-induced demand would have nearly doubled.

The assumption of surgical fees uncorrelated with surgeon concentration, however, considerably understates the full impact of excess surgeon supply on

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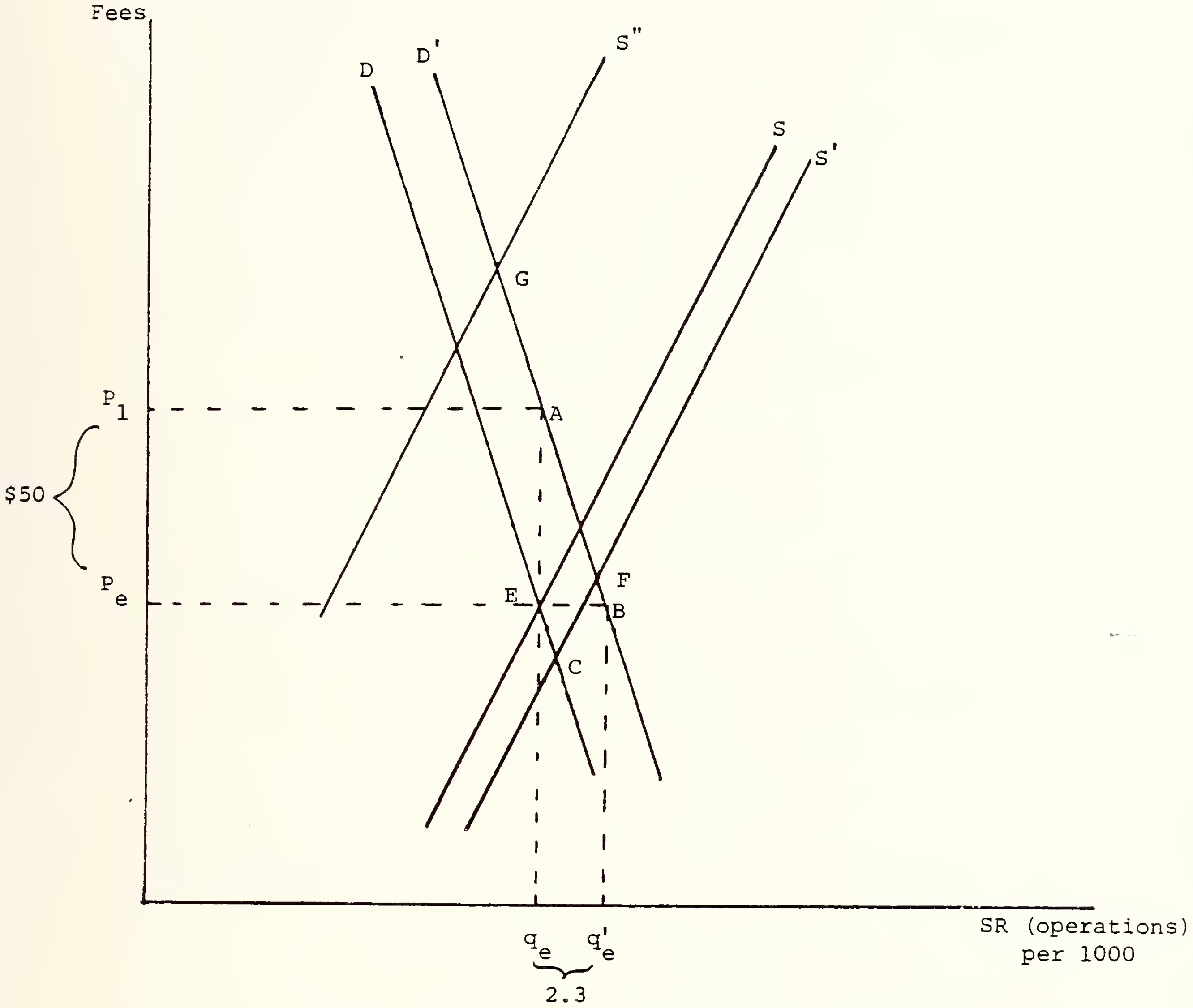
*A simplifying assumption that errs on the side of underestimating the cost impact.

FIGURE VII-1: QUANTITATIVE MEASURE OF THE INDUCEMENT EFFECT



costs. Respecifying the demand equation (5) in terms of price (see Table VII-3, eq. (8)) shows in a dramatic way the implications of inducement for a highly inelastic demand. Referring to Figure VII-1, a one standard deviation increase in SP above the equilibrium would result in a new, upward-shifted demand to D'. In the short-run with utilization per capita unchanged ($=q_e$), fees, if unconstrained, would rise \$50 (.13 x \$383) from p_e to p_1 (an elasticity of .36 in real terms). Alternatively, as discussed above, if fees were rigid in the short-run, "desired" operations per 1000 population would increase by 2.3 to q_e' in Figure VII-1.

Without inducement, one would expect the new equilibrium fee-utilization combination associated with greater physician density to lie somewhere below E, say point C. Utilization rates would increase, not because physicians arbitrarily expand elective surgical workloads, but rather because new competition among surgeons has forced them to lower fees, essentially making discretionary surgery "a better buy." Mr. Jones now takes a few days off work to take care of a small cataract that has been bothering him for some time. With inducement, it is possible (but not necessary) for the new equilibrium to lie somewhere above and to the right of E, assuming positively sloped supply curves.

Equation (9) represents an equilibrium solution to the model where all explanatory variables, save surgeon density, are exogenous. It is the "price equation" usually referred to in the literature. All demand-specific variables should exhibit the same signs in both the "demand price" and "equilibrium price" equations while those entering the supply equation positively should have negative signs. Some variables, including SP, are stable (e.g., health status, income, coinsurance, time), but many others are not. Part of the problem is due to the collinearity among $\widehat{SP}$, predicted SP taken from the first stage, and the included variables; only four amenity variables relevant to surgeon location have been dropped. Thus, the results should be interpreted cautiously. (The possibility that disequilibrium fees are being observed instead is considered below.)

Certainly the most dramatic finding is the strong, positive influence surgeon density has on equilibrium surgical fees. This is true even after purging SP of the feedback effect of higher fees on surgeon migration. If the coefficient for SP in eq. (9) is attributed solely to "pure" physician inducement, then a 10 percent increase in surgeon density results in inducement of fees of $29, or a long-run elasticity of .90 versus .36 for demand prices alone. This would imply only a marginal decline in net incomes from surgery with increased competition.*

Long-run SP price elasticities exceeding short-run, constant output elasticities, however, are inconsistent with the notion of positively sloped, rightward-shifted supply curves (compare points A and F in Figure VII-1). The clear implication is either that supply is shifting in rather than out with increased surgeon density (point G in Figure VII-1), or that supply is backward-sloped.

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*Let

$$\text{(f.1)} \quad NY = GY - C = pW - C$$

be surgical net income (NY), calculated as the difference between gross income (GY) and costs (C). Dividing though by a cost-of-living index removes most of the income variation due to factor costs (C). Differentiating (f.1) with respect to SP and multiplying through by (SP/p) gives

$$e^{P}_{SP} = \alpha - e^{W}_{SP}$$

where the e's correspond to surgeon fee (p) and workload (w) elasticities with respect to SP, and α = the percent change in net income. If demand is assumed perfectly inelastic, then $e^{W}_{SP} = -1$, and $\alpha = -.1$ for $e^{P}_{SP} = .90$. Ceteris paribus, a 10 percent increase in surgeon competition lowers surgical net incomes by only about 1 percent.

Workloads clearly fall with more surgeons: a 10 percent increase in SP around the mean of .30 implies a drop of 35 (-1159 x .03) operations per surgeon on average holding price effects constant.* The net impact on supply can be determined by differentiating SS = W•SP with respect to SP, and evaluating the result at the sample means for SP and W:

$$\frac{dSS}{dSP} = \frac{dW}{dSP} \cdot SP + W$$

$$= -1159 \cdot (.30) + 281 = -67,$$

a net decrease in desired supply of 67 operations per surgeon, holding fees and other variables constant. Thus, positive additions to the surgical manpower pool are more than offset by declining workloads of established physicians.

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*The large, estimated drop in surgical workloads likely overestimates the true decline in operations actually performed by surgeons. Nonsurgeons perform surgery, and it is their surgical workloads which probably fall fastest with surgeon inmigration. The decline in so-called surgical workloads can be decomposed as follows:

$$\text{(f.2)} \qquad \frac{dW}{dSP} = \frac{dW_{SP}}{dSP} + \frac{dW_O}{dSP} \cdot \frac{O}{SP} + W_O \frac{d(O/SP)}{dSP}$$

Where W_{SP} and W_O = surgical workloads of surgeons and nonsurgeons, respectively, and O/SP = ratio of nonsurgeons to surgeons in an area. The last term on the right-hand-side is positive: in rural areas there are 2.8 nonsurgeons for every surgeon compared to 3.6 in large SMSAs. Rearranging (f.2), the percent change in operative workloads for surgeons can be written as:

$$\%\Delta W_{SP} = -\frac{W_O}{W_{SP}} \cdot \frac{O}{SP} \cdot (\%\Delta O/SP + \%\Delta W_O) + \frac{dW/dSP}{W_{SP}} \cdot$$

If a two standard deviation increase in SP (roughly the difference between rural and large SMSAs) led to an 80 percent decline in operative workloads of nonsurgeons, then desired surgeon operative workloads may be little affected. Assume W_O/W_{SP} = .2, O/SP = 3, $\%\Delta O/SP$ = .29, $\%\Delta W$ = -.8, $dW/dSP = -1159 \cdot 0.26 =$ -301, and W_{SP} = 700, then:

$$\%\Delta W_{SP} = -(.2)(3)(.29-.8) - (301/700) = -12\%.$$

Such a calculation is very crude and all the evidence suggests that surgeon operative workloads are much lower in surgeon dense areas. This may be due to price effects and a backward-bending supply, however, which are considered in the text.

This reduced amount is what physicians apparently would like to provide in toto at original fee levels. But then why induce at all? The answer may lie in our aggregating very different markets into one national pool and assuming each follows the same set of economic laws. Large cross-sectional variation exists in the types of PSUs being compared, and Ramsey (1980, p. 18) has warned against specification biases that could result from comparing very disparate markets. To determine the effect of PSU size on our results, the model was re-estimated for three subsamples: nonmetropolitan PSUs (1604 PSU years); small SMSAs (686 PSU years); and large SMSAs (546 PSU years). Large SMSAs were defined as those having populations greater than 500,000. Condensed regression results, focussing on the endogenous variables, are presented in Table VII-4. Complete tables are provided for the interested reader in Appendix D.

Summarizing the results, first for non-metropolitan areas, we find the kind of market a neoclassicist would expect: (1) a small negative price elasticity of demand ($e_P^{SR} = - .22$); (2) no discernable surgical inducement; (3) falling equilibrium fees with greater surgical concentration; (4) a positive workload fee elasticity ($e_P^W = .5$); and (5) a strong positive shift in supply (dSS/dSP = 18.3 per 10 percentage point increase in SP), although average workloads decline somewhat.

Contrary to conventional wisdom, surgeons are attracted to these areas if fees are higher and workloads lower. The surgeon location decision with respect to fees is evidently quite high in these areas --on the order of 2.5. Higher workloads, ceteris paribus, discourage surgeon in-migration, but not to any great degree ($e_W = -.22$). More hospital beds also attract physicians into non-metropolitan areas ($e_{BEDPC} = 0.5$) as do colleges.* All other things

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*Surgeons are also more apt to locate in colder rural areas, possibly because of winter sports. Why they would also locate in higher wage, rural areas is unknown, unless WAGE is also proxying proximity to a larger, urban area.

TABLE VII-4:

TWO-STAGE LEAST SQUARES REGRESSIONS: NON-METRO, SMALL AND LARGE METRO PSUs, 1969-1976
(t-values in parentheses)

INDEPENDENT VARIABLE	DEPENDENT VARIABLE					
	SR (12)	SRE (13)	P (14)	P (15)	W (16)	SP (17)
REGION: NON-METRO						
P	-0.043 (1.7)*	-0.017 (1.0)			0.784 (1.1)	0.0014 (7.0)**
SP	5.5 (.6)	3.6 (.6)	44.4 (.5)	-215.9 (3.2)**	-718.0 (2.1)**	
W						-0.00008 (4.7)**
SR			-7.79 (2.7)**			
R^2 (F)	0.08 (7)	0.06 (5)	0.02 (1.5)	0.21 (21)	0.06 (17)	0.37 (105)
REGION: SMALL METRO						
P	0.004 (.1)	0.013 (.6)			-0.047 (.4)	0.0002 (.8)
SP	5.57 (.2)	12.7 (.8)	-66.1 (1.4)	459.1 (4.4)**	-667.4 (8.4)**	
W						-0.001 (7.3)**
SR			0.51 (.6)			
R^2 (F)	0.06 (2)	0.03 (1.1)	0.23 (10)	0.22 (10)	0.18 (31)	0.35 (41)
REGION: LARGE METRO						
P	-0.037 (1.7)*	-0.032 (2.2)**			-0.177 (5.0)**	-0.00008 (1.0)
SP	25.3 (1.2)	14.20 (1.0)	534.1 (4.3)**	680.0 (6.7)**	-395.0 (10.1)**	
W						-0.0016 (9.1)**
SR			-5.27 (3.0)**			
R^2 (F)	0.23 (8)	0.14 (5)	0.35 (15)	0.50 (27)	0.36 (59)	0.42 (42)

Note: Complete regression results in Appendix D.

* Significant at ten percent level.

**Significant at five percent level.

held constant, surgeons were moving into rural areas at a rate of .009 per 1000 population per annum over the period, 1969-76. Thus, over a 10 year period a rural PSU with 10,000 people could expect to gain approximately 1 surgeon without any increase in fees, hospital beds, etc. Higher fees, in particular, could accelerate this inmigration.

Small metropolitan areas (SMSAs less than 500,000) show a different picture in two major respects: (1) higher equilibrium fees with increasing surgeon concentration; and (2) inward shifted supply ($dSS/dSP = -3.3$ operations per 10 percentage point increase in SP). Both demand and supply are quite price inelastic, and demand prices are inversely correlated with surgeon concentration although the coefficient is significant only at a 15 percent confidence level.

Large metropolitan areas present a dramatic contrast from rural and small metropolitan areas: (1) demand -- particularly elective surgery -- varies inversely with both surgeon fees ($e^{SR}_{P} = -.20$; $e^{SRE}_{P} = -.34$) and hospital costs ($e^{SR}_{HEXPA} = -.06$); (2) utilization varies positively with surgeon concentration (although the relationship is not statistically significant);* (3) both demand and equilibrium fees are positively related to SP; and (4) supply is positively shifted and backward-bending ($dSS/dSP = 3.5$ operations/10 percentage point increase in SP; $e^{SP}_{P} = -.35$).

It may help to refer to Figure VII-2 (a, b, c) to understand the comparative statics implications of these conflicting results. Non-metropolitan areas obey conventional economic theory. New surgeons moving into rural areas leave demand more-or-less unaffected. Total supply shifts

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*Decomposing the sample by metropolitan area reduces the significance of the relationship between surgery demand and SP. The fact that the SP coefficients are all positive in the SR and SRE equations in Table VII-4, although insignificant individually, add up to a significant relationship for the combined sample.

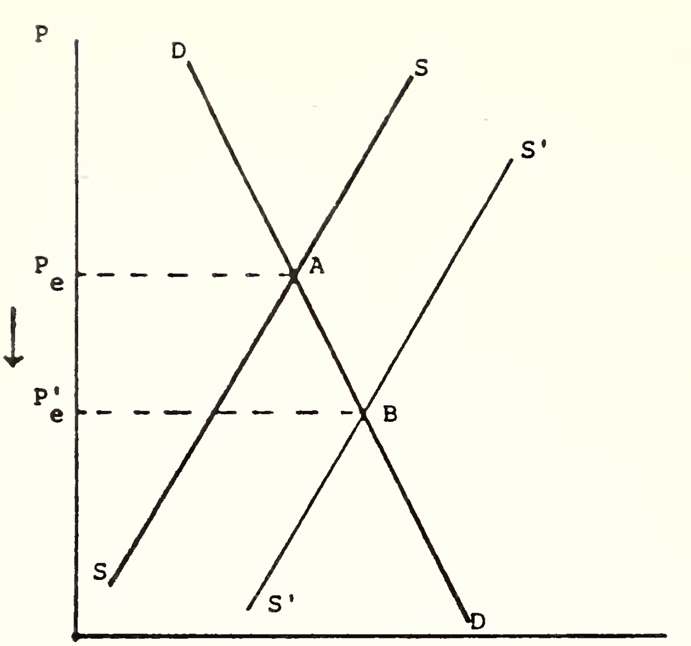

Figure VII-2a
Non-Metro Areas

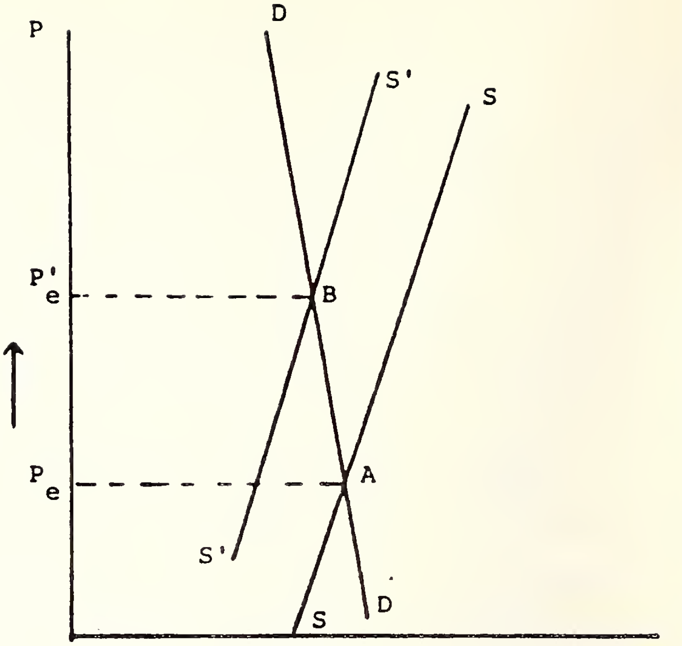

Figure VII-2b
Small Metro Areas

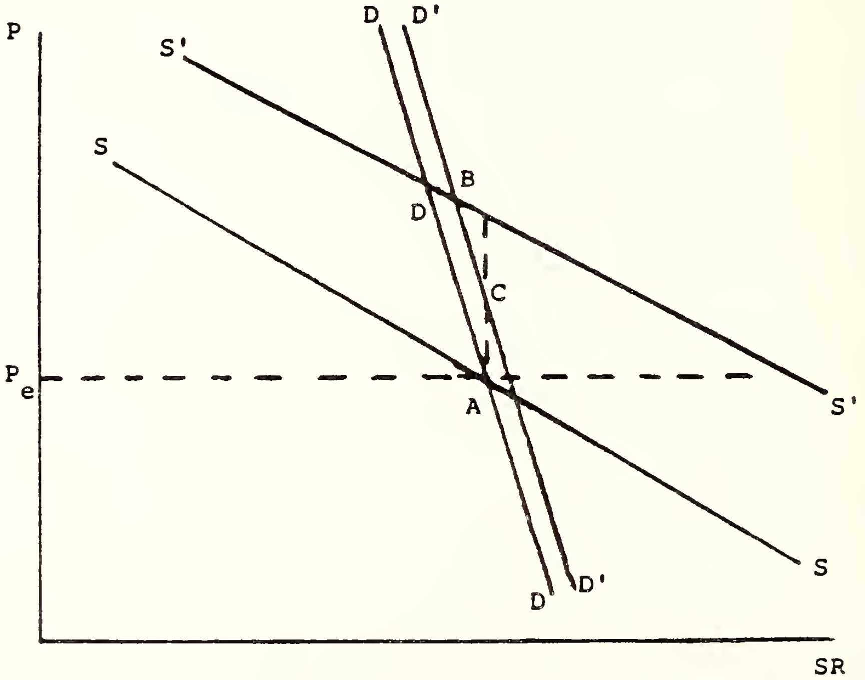

Figure VII-2c
Large Metro Areas

out even though average workloads decline, and a new equilibrium at B is achieved through a simple movement down along the non-induced demand curve. Utilization is greater because fees are lower, not because physicians exercise discretionary power over demand. With very high workloads already, there is no need to shift demand.

As shown in Figure VII-2b, small SMSAs exhibit opposite effects with increasing surgeon concentration, viz., higher fees with no real change in surgery rates, but again induced demand apparently is not the primary reason. Desired surgeon workloads in these communities fall so rapidly that new surgeon supplies are more than completely offset, thereby reducing desired supply. With a very inelastic demand curve, equilibrium fees rise significantly as patients (and their insurors) compete for scarce, increasingly expensive surgeon time.

Large SMSAs present still another scenario (see Figure VII-2c). Like rural areas, and unlike small metropolitan areas, net surgeon inmigration increases supply. Yet, unlike either area, equilibrium prices exceed demand prices with surgeon inmigration into large SMSAs. With a downward sloping demand curve, this paradoxical result can only be explained by a negatively sloped, or backward-bending supply curve in the presence of inducement. If backward-bending supply cuts demand from below (implying a greater negative supply price elasticity), then inducement necessarily leads to higher equilibrium fees after an influx of surgeons.* The coefficients for large

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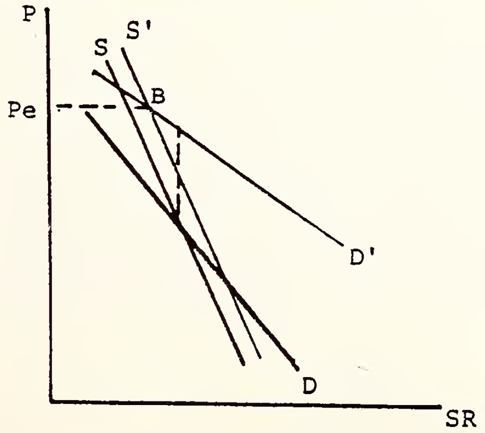
*An outward supply shift to S' at equilibrium results in a demand shift from D to D'. Demand prices would rise to B in the short-run, then as surgeons move back along the new supply curve, final equilibrium prices stabilize at P_e.



metro areas, however, suggest that supply is negative and more price elastic than demand (see Figure VII-2c), cutting demand from above. The price elasticity of demand, evaluated at the means is -.20; the price elasticity of supply, $e_P^{SS} = d(W\cdot SP)/dP = (dW/dP)\cdot SP\cdot P/SR = (-.177)(.36)(336)/63 = -.34$. Thus, prices above p_e imply greater and greater shortages and excess demand.

Outward shifts in supply would lead to excess supply at A, encouraging surgeons to induce demand (D'D'), raising demand prices to C. As demand prices rise, however, supply falls more quickly than demand, resulting in a new equilibrium at B. Consequently, the comparative statics results of an influx of surgeons are (a) significantly higher fees and (b) slight reductions (!) in surgery rates.

There are several reasons to question the reasonableness of this model, however. First, the equilibrium assumption goes against what we generally know about the surgeon market in urban areas which is usually characterized by chronic excess supply, not shortages. Second, the model is unstable in Walrasian terms; that is, an outward supply shift at equilibrium (A) resulting in excess supply at original prices should lead to falling, not rising, prices as physicians compete for "scarce" patients. A new equilibrium would only be achieved when supply again becomes positively sloped. The system is stable in Marshallian terms, on the other hand. At output A, demand prices are below supply prices with increased supply, implying a reduction in quantity supplied and a movement towards a new equilibrium at B (with inducement). Normally, backward-rising supply curves respond to discrepancies in quantity demanded and supplied through Walrasian price competition (see Baumol, 1967, p. 121), but suppose certain institutional rigidities existed in the market, placing a natural floor on prices. Usual, customary, and reasonable reimbursement methods, which base insurance payments on stated physician charges, do in fact constitute such a floor. Unwilling to lower fees in the first instance, surgeons may take the opposite tack of raising charges on their remaining patients to (partially) recoup reductions in surgical workloads due to surgeon in-migration. Once prices start to rise instead of fall, however, Marshallian dynamics come into play: surgeons begin to move back along their supply curves and a new, higher equilibrium fee is the outcome.

To simplify the dynamics as much as possible, consider a market with one surgeon (S1) and one nonsurgeon (NS) each performing some surgery (see Figure VII-3).* The markets are segmented to the extent that the surgeon performs all of the more complicated surgery, leaving the remainder to the nonsurgeon. Further assume the surgeon has chosen a fee and an output level (A) on the backward-bending portion of his supply curve.** The nonsurgeon is left to meet the demand beyond q_{S1} below P_{S1} (depicted as $D_{NS}(q_{S1})$ in Figure VII-3b). Observed fees in the area would be a weighted average of P_{S1} and P_{NS}, while $q = q_{S1} + q_{NS}$ would be the observed surgery rate.

With two, equally trained surgeons competing, total surgical demand (D_T) is split between the two ($D' = D_{S1} = D_{S2}$). Therefore, at his usual charge, P_{S1}, surgeon 1 initially experiences a loss of patients (roughly 50 percent) due to an inward shift in demand. Knowing his patients pay only a small percentage (if anything) out-of-pocket, coupled with the fact that if he lowers fees to regain lost patients his UCR allowable fee will fall, the surgeon may simply raise his fees to his remaining patients and move back

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*The model described below deviates from purely competitive assumptions in material ways, e.g., segmented markets, few competitors, downward-sloping demand curves at the firm (physician) level, and is offered as an illustration only. True market supply curves under monopolistic competition do not exist, for example, as posited in the estimated equilibrium model.

**Ordinarily a marginal revenue curve would be below demand, further restricting output. For illustrative purposes it is ignored -- effectively making the surgeon a perfect price discriminator.

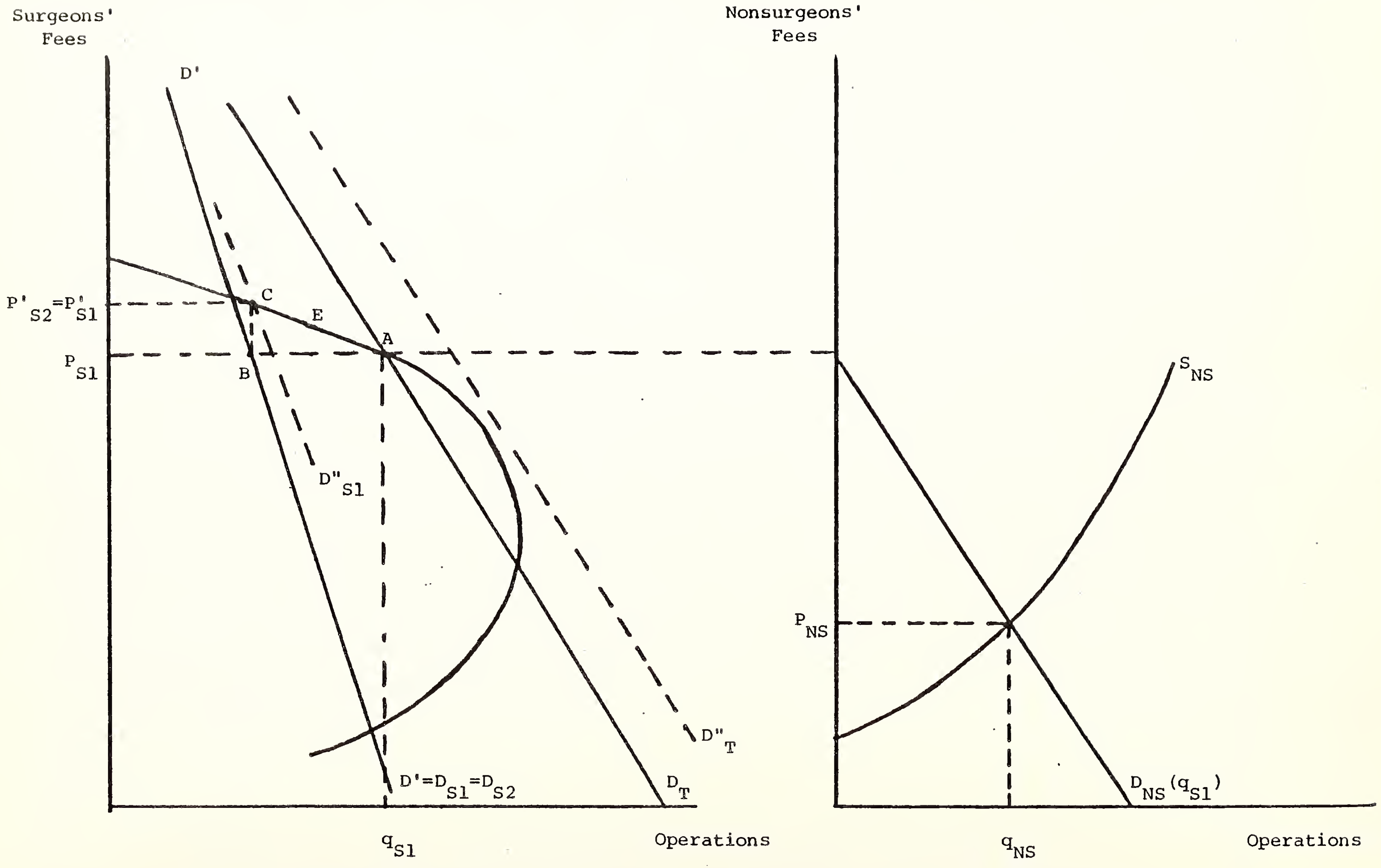

Figure VII-3a
Surgeon Market

Figure VII-3b
Nonsurgeon Market

along his supply curve to C.[*] The competitive effect on the new surgeon would be similar if he initially set his fees equal to those of S1. If he initially set them below P_{S1}, his income short-fall would be greater, leading to even greater price inducement.[**] The increase in surgeon density under such a scenario would result in: (a) much higher average fees; (b) declines in surgical workloads of non-surgeons; (c) some fee and quantity inducement; and (d) overall reductions in operations per surgeon as more surgeons split up the relatively constant surgical demand (including some inducement).

While some "unnecessary" surgery may result, the principal inducement effect is on prices, not output. Hence, the problem in surgeon-dense areas, _if_ physician fee-surgery combinations constitute true equilibriums, is not that a lot of unnecessary surgery is being performed, but rather that very high fees are being paid for that which is being done. This is due, in part, to the fact that more surgery is being done by qualified surgeons. It is also due to the perverse market response to increased surgeon density, with quantity supplied falling rather than rising.

Pauly-Satterthwaite Increasing Monopoly Model

Pauly and Satterthwaite (1980) at Northwestern University have recently proposed a new theory of "increasing monopoly" to account for the positive correlation between physicians per capita and fees. It is predicated on the assumption that "consumer information, and consequently the degree of certainty about other sellers' quality levels, may decrease as the number of sellers increases" (p. 27). Empirical tests of the hypothesis have centered on alternative specifications of the extent and quality of consumer information. Primary among these is the absolute number of physicians in the consumer's market area, or physicians per square mile. Others, having to do with the ease of information flows within a specified area, include public transportation, population growth and turnover.

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[*] He may even forego the additional out-of-pocket payment, making the increase in his final transactions price a little lower than the increase in stated prices.

[**] If patients were less sensitive to utilization inducement than to price inducement (e.g., "Mrs. Jones, why don't you come in next week for another visit?"), surgeons may achieve a new equilibrium at an output level somewhat greater than q_{S1} per surgeon, e.g., point E. On the relative sensitivity of patients to fee vs. utilization inducement, see Feldstein (1970), Roehrig (1980), Pauly-Satterthwaite (1980), and Reinhardt (1978).

In our study we have included a limited test of the increasing monopoly model by including surgeons per square mile (SURGDEN) along with surgeons per capita as explanatory variables. (Other proxies for information flows were unavailable.) In Pauly-Satterthwaite's empirical work, these two measures were highly correlated, which is not surprising as their work was confined to the 100 largest SMSAs. Using a national sample of 350 PSUs, urban and rural, reduces the correlation to .29, permitting a finer separation of the two variables.

The inclusion of surgeons per square mile, if anything, increased the significance of the surgeon per capita variable in the structural demand and equilibrium fee equations (see Appendix E). SURGDEN had a negative, but insignificant impact on utilization and equilibrium fees which is counter to the expectations and empirical findings of Pauly-Satterthwaite. It is possible that other measures of consumer information like public transportation, percent of families moved, etc. are needed in conjunction with SURGDEN to fully test the theory. Nevertheless, our results --at least regarding surgery -- are robust with regard to physician density on a geographic basis.

Disequilibrium Results

The assumption that fees adjust within the period to equate the demand for and supply of surgical operations is a particularly strong one in light of published statistics on surgeons. The SOSSUS report of surgical manpower (ACS, 1975) concluded that the:

> "average annual workload (1600 to 2000 CRV) of the surgical specialist in this country appears light by most standards. The data both in the questionnaire study and the area studies suggest that most surgeons could carry a higher operative workload" (p. 86).

Hughes _et_ _al_. (1972) corroborate this conclusion through questionnaire responses: in general, surgeons state that they are willing to provide more operations at prevailing market prices.* This runs counter to the long-standing concern over physician shortages in other specialties and suggests an alternative approach to the problem of induced demand.

Consider Figure VII-4 which shows normally sloped demand and supply curves for surgery, based on underlying medical and economic factors. If prices were perfectly flexible, only equilibrium price-utilization combinations would be observed (i.e., p_e and q_e). What we know about surgeon workloads, however, suggests that fees in many areas may be rigid downwards, that desired supply exceeds desired demand at (rigid, or sluggish) p_1. In this instance, observed utilization figures should be on, or very near, the demand curve, presuming that the "short-side" demanders-of-care realize their planned trade, while suppliers' preferences remain unfulfilled (Green, 1978, p. 30). The inducement hypothesis contends, however, that surgeons in excess supply can and do exert some discretionary power over demand, effectively rotating it to the right to some (unknown) degree, α, (to D', for example). At unchanged p_1 this rotation should manifest itself in a higher utilization rate, D'_1.

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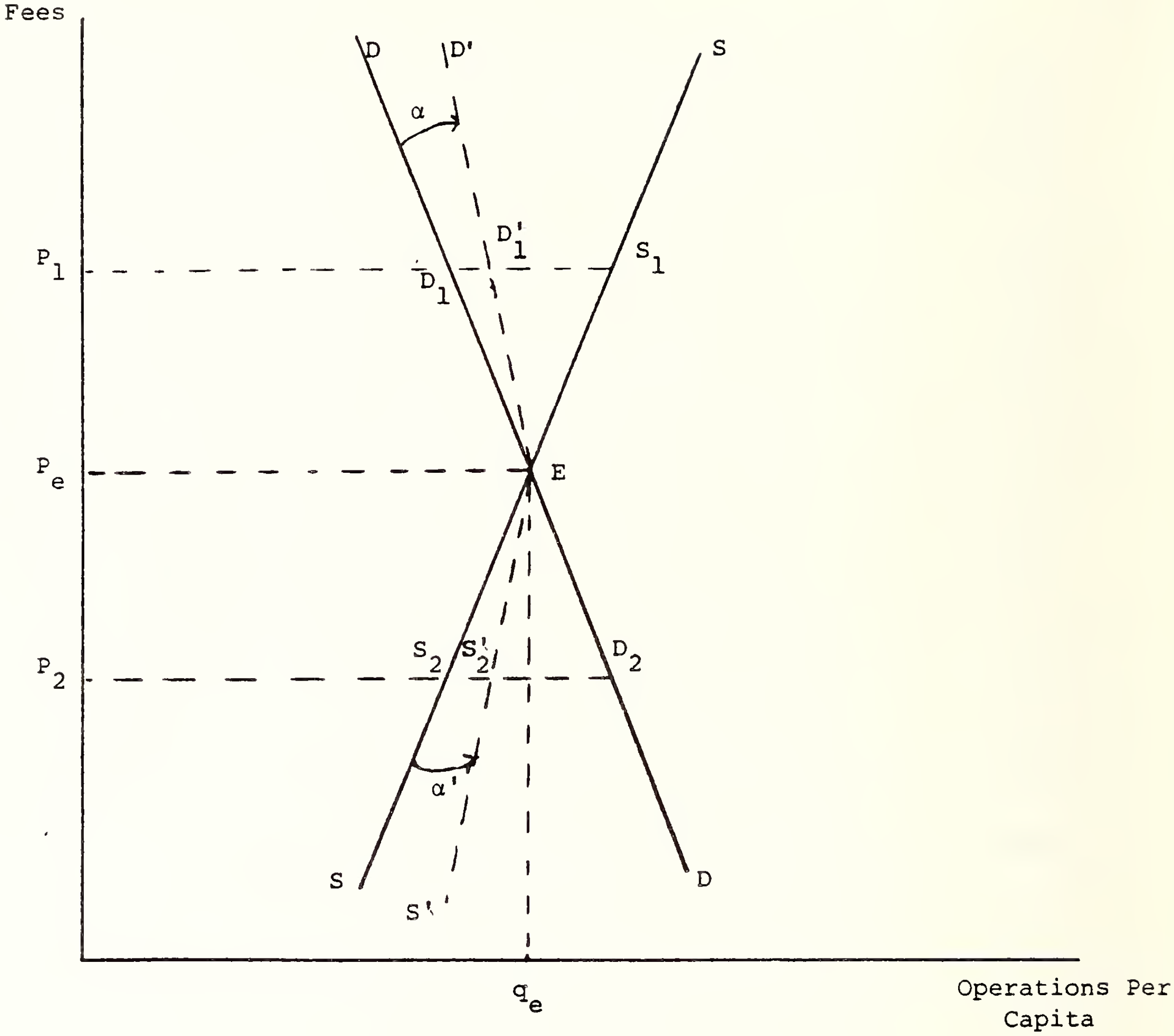
*For an interesting insight into why surgeons are not poor when there are so many of them, see Owens (1974).

FIGURE VII-4 A Disequilibrium Analysis



Of course, many, but certainly not all, surgeons practice in glutted markets. A few, most prevalently in rural areas but also in some large, unattractive cities, work in shortage areas. Yett (1978) argues that the positive association between fees and utilization may be due to a small, but important number of physicians practicing in underserved areas, partially filling an excess demand gap. This idea can be treated more formally as a rightward rotation in the supply curve below p_e in Figure VII-4, as surgeons fill part of the excess demand gap, at least in the short-run. If, as Yett suggests, we are observing price-quantity combinations not along demand, DED, but DES', then a positive correlation between fees and surgeon supply is, in fact, possible, without any real inducement. The observed correlation could be due to a specification bias arising from chronic disequilibrium in shortage areas.

Green (1978) points out that if the observations can be separated into excess supply and demand regimes, then a direct estimate of the shift effect could be derived from estimating

$$(7.6) \qquad Q = \begin{cases} S + \alpha\,(D-S) & D>S \\ D + \alpha'(S-D) & D<S \end{cases}$$

and evaluating the supply coefficients (including surgeons per capita) where D<S. Without inducement, α' should equal zero; that is, observed surgery rates should be a function of demand factors alone. Expanding (7.6) we have

$$(7.7) \qquad SR_{D>S} = (1 - \alpha)S + \alpha D$$

and

$$(7.8) \qquad SR_{D<S} = (1 - \alpha')D + \alpha' S.$$

Substituting the respective demand and supply vectors of explanatory variables (including P and SP) for D and S and estimating (7.7) and (7.8) using OLS, we should find that in excess supply regions utilization is demand-dominated while in excess demand regions supply is more constraining. Also, by segmenting our sample in this way and focussing on excess supply regions, there is less chance that a positive inducement effect may simply be due to physician shortages. If demand shift is found in surplus areas, this would reinforce the earlier, equilibrium findings.

Segmenting the sample is difficult to do a priori because we do not know desired demands and supplies at going market fees for individual regions. As a first approximation we split the PSU sample at the mean physician workload of 280 operations per surgeon. Those PSUs whose average workloads were above 280 were considered "shortage" areas while those where $W < 280$ were designated surplus areas. Two hundred thirty-three PSUs were considered surgeon-surplus areas using this algorithm; 119, shortage areas. Certainly some classification error exists in such a procedure,* but the results should be less contaminated than under the simplifying assumption of equilibrium.

The results are reported in Table VII-5. As expected for those physicians with heavy surgical workloads, observed utilization rates are almost exclusively determined by physician supplies; fees and most socioeconomic factors have no discernable effect. Only disability days and education (which may be proxying health status and occupational hazards to some extent) show a statistically significant positive effect on utilization.

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*280 operations per year works out to 5.5 operations per week for 50 weeks, a number somewhat higher than found in the SOSSUS report (ACS, 1975, p. 40). Part of the difference is due to operative workloads of nonsurgeons which are included in the numerator but not in the denominator of our workload measure. Using workloads as a measure of market disequilibrium presumes the underlying demand-supply characteristics in shortage and surplus areas to be similar on average. Low workloads may not uniquely identify surplus areas if underlying supply characteristics (e.g., operating costs, physician income-leisure preferences) result in a drastic leftward shift in desired supply. But such a result seems inconsistent with physician attitudes concerning their low workloads in many areas; surgeons with low workloads generally would like to do more surgery.

Table VII-5:

TOTAL SURGERY RATE OLS REGRESSIONS FOR HIGH AND LOW SURGEON WORKLOAD AREAS
(t-values in parentheses)

INDEPENDENT VARIABLE	SAMPLE	
	W > 280 (18)	W < 280 (19)
P	-0.009	-0.023
	(0.5)	(3.0)**
SP	132.3	13.26
	(12.5)**	(2.8)**
ELDPC	34.2	62.5
	(1.6)	(4.2)**
MIDPC	25.5	27.0
	(1.3)	(2.0)**
YAPC	27.8	3.5
	(1.3)	(0.2)
F	-2.11	-19.3
	(0.1)	(1.2)
WHITE	6.7	5.0
	(1.0)	(1.3)
EDHS	19.5	15.0
	(2.3)**	(2.4)**
EDCL	-5.4	5.6
	(0.5)	(0.8)
DISPC	13.4	16.6
	(2.6)**	(4.2)**
INC (000)	0.6	0.5
	(1.6)	(2.8)**
COIN	4.5	-3.59
	(1.1)	(1.7)*
HEXPA (00)	0.5	-0.2
	(1.4)	(5.5)**
EMP	-16.0	9.3
	(1.5)	(1.2)
PROF	-13.7	-0.3
	(0.9)	(0.0)
CLERK	10.8	3.8
	(0.8)	(0.4)

Table VII-5: (cont.)

	SAMPLE	
INDEPENDENT VARIABLE	W > 280 (18)	W < 280 (19)
BLUEC	-4.6	-5.5
	(0.4)	(0.7)
GPPC	-8.5	-14.4
	(1.0)	(2.4)**
NSP	0.4	-6.3
	(0.1)	(1.2)
BEDPC	75.5	33.8
	(0.2)	(0.1)
WAGE	0.19	0.18
	(0.1)	(0.4)
SMSA	3.1	5.0
	(1.0)	(3.1)**
TIME	0.47	0.18
	(1.4)	(1.0)
CONST	12.3	35.1
	(0.6)	(2.5)**
R^2	0.35	0.16
(F)	(19.6)	(13.2)

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*Significant at ten percent level.

**Significant at five percent level.

For surgeon-scarce areas, the surgery rate elasticity with respect to surgeon concentration is .28 compared with .09 for the entire sample. Where surgeon workloads are lighter, demand variables play a much greater role. Fees show a significant, negative effect on utilization ($e_p = -.13$); income a positive effect ($e_y = .09$). (The negative sign for the coinsurance variable is theoretically unexpected, however.) Other demand-side variables like age distribution, disability days, education, and the average cost of a hospital admission ($e_{HEXPA}=-.04$) were also significant.

Even in excess supply areas, however, the impact of physician concentration on utilization does not disappear. SP continues to have a significant, positive sign although the elasticity has been considerably reduced ($e_{SP}=.08$). Furthermore, an inelastic demand implies that most of the inducement effect is reflected in higher fees, as discussed above. A ten percentage point increase in the surgeon-population ratio increases demand prices by nearly $60 per operation (.10(13.26/.023), cost-of-living adjusted, in excess supply areas.

One could argue that inducement would disappear in overserved areas once fees have had time to adjust to competition, but there is little evidence of such a competitive effect. First, cost-of-living-adjusted surgical fees rose over 16 percent from 1969 to 1976 in surgeon-dense areas (see Table VI-4 in the preceding chapter) even with a slight increase in density (SP rose from .395 to .429). Second, according to reduced-form regressions (not shown) of adjusted fees, controlling for changes in other exogenous variables, no evidence for fees declining in low surgeon workload areas was found: the TIME coefficient was negative, but quite insignificant.

In summary, the usual competitive mechanism of price adjustments to eliminate demand-supply gaps appears strangely altered, if not altogether missing, in the market for surgical services. For instance, structural workload equations for the two workload regimes based on an (admittedly untenable) equilibrium assumption, show a drastically different supply elasticity with respect to fees.* In underserved areas, the supply elasticity is a statistically significant +0.74, implying a positive physician response to fee increases. In overserved areas, the elasticity is -0.87, indicative of a strong backward-bending supply curve. Negative "supply" elasticities may simply derive from the fact that in overserved regions, utilization rates are demand-constrained and supply is unobservable. But then, how else can we explain higher fees and lower workloads in areas of high surgeon concentration? Either the lower workloads, while real, are not desirable (the _dis_equilibrium case), or they are desirable (the equilibrium case) and surgeons choose to take more leisure and keep fees high. How they are able to do this in the presence of more-and-more competitors can be explained, at least in part, by exerting discretionary power over fees.

Discussion

Whether physicians can and do exert extraordinary power over patients in the services they purchase and the fees paid has been partially addressed in our investigation of surgery. Strong evidence has been presented showing _positive_ surgeon elasticities with respect to both surgical rates and fees, evidence supportive of the more limited work of Fuchs and his colleagues (and antithetical to findings by Sloan and Pauly). As demand for surgery is highly price inelastic, most of the inducement effect manifests itself in terms of higher fees and not additional surgery, although some evidence for "induced" operations was found.

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*Two stage results by workload regime are not shown, primarily because the equilibrium assumption upon which the second-stage estimates are based is questionable. They are mentioned here as an example of the results that would obtain if (a) surgical workloads were in fact, low, but (b) still in equilibrium.

Of notable interest is the net effect of surgeon supplies on equilibrium fees after markets adjust to surgeon inmigration. Our findings confirm the alleged existence of sharply declining surgical workloads of all physicians in surgeon-dense areas. This has resulted in much higher fees for surgical procedures, most of which are now paid for by third-party payors. In fact the growing prevalence of UCR payment methods (e.g., Medicare, Blue Shield, Medicaid) has encouraged physicians to systematically raise prices, realizing that the net out-of-pocket price of surgery has been falling.

Many explanations can be found in the literature for the positive association of fees and physician supplies that do not resort to inducement. Some of the more popular include:

1) Failure to adjust for cost-of-living differences;

2) Simultaneous equation bias resulting from physicians being attracted to high fee areas;

3) Failure to account for other important demand factors like insurance, health status, patient time prices, and the prices of complementary services (e.g., hospitalization);

4) Failure to account for in- and outmigration of patients for care;

5) Systematic variations in the nature of the services rendered, changing the quality of the product;

6) Imperfect information on quality and fees that creates stronger monopoly positions for physicians operating in physician-dense areas;

7) Chronic physician shortage areas, wherein physicians increase supply to meet part of a latent demand with only minor price increases; and

8) Lack of a theoretically consistent, convincing argument for the presence and extent of inducement.

This study addresses many, but unfortunately not all, of these criticisms. All monetary variables, including the fee index, were deflated by a COL index, effectively placing all PSUs on a common, 1969 BLS base. Thus, the trends in fees that we observe in the descriptive and econometric results are in terms of real purchasing power. In the equilibrium fee equation, real surgical fees were found to be rising $4.41 per year, holding all other factors constant. They were also significantly higher in surgeon-dense areas.

A simultaneous equation model was estimated using a two-stage instrumental variables approach. Thus, the feedback effect of high relative fees on surgeon location should have been purged from the demand estimation. Under-identification of the demand equation has also been a problem, but a significant number of exogenous variables have been added from other structural equations.

Many other important demand variables not included in other studies have been included here: coinsurance, disability days, income, age and sex distribution of the population, race, and education. Also included are measures of complementary hospital prices and occupational status (as a proxy for time price, health, and insurance status).

Bordercrossing has been addressed, first, by working with a population-based surgery measure (which captures outmigration) and, second, by the surgeon-population ratios in nearby metropolitan areas. Presumably, the use of PSU, rather than county, data has further reduced the bordercrossing problem.

Changes in the quality and nature of the product may explain part of our findings although some attempts to adjust for them have been made. First, by limiting the analysis to surgery, less variation likely exists in what constitutes output than with office visits. Raw, unweighted surgery counts were used in the munerator, however. Thus, it is possible that the surgical procedure mix may vary systematically with surgeon density, but this does not explain the higher fees as national procedure weights were used in creating the fee index. Second, amenity-related variations in the product, e.g., longer visit lengths, shorter waiting times, nicer offices, should be less important for surgery than for regular office visits. Still, it is possible that part of the higher fees may be explained by left-out amenities that patients are genuinely willing to pay for. Very high insurance coverage simultaneously creates a moral hazard, on the other hand, making it difficult to determine the true value (to patients) of these amenities.

Another, uncontrolled for, source of product variation are the credentials and training of surgeons. Fees and utilization may be higher in surgeon-dense areas because physicians are better trained and more specialized. Fees may rise simply because more skilled surgeons are substituting for GPs and for less specialized surgeons in performing surgery in surgeon-dense areas. Again, our fee index concentrated on six relatively common procedures, none of which are widely done by GPs. Four of the six (cholecystectomy, hemmorhoidectomy, hernia repair, and prostatectomy) are routine surgical procedures involving little surgical sophistication while the last two would likely be done by opthalmologists (lens extraction) and surgical oncologists or other specialized surgeons (radical mastectomy). It is not at all clear that surgical sophistication adds a great deal to the quality of care when confining the list to just these six procedures. Population-based utilization rates, furthermore, should adjust for higher surgical specialist demand due to inmigration.

That the detail and accuracy of information concerning physician fees and competence may be inversely correlated with physician density is an argument recently proposed by Pauly and Satterthwaite (1980). Instead of physician-specific demand curves shifting in and becoming more elastic with greater physician supply (the orthodox assumption), they argue the opposite:

when there are a lot of physicians relative to patients, information becomes more expensive to acquire, resulting in more, rather than less, monopoly power on the part of the physician. One could argue that it becomes a semantic question whether physicians "shift" demand or simply take advantage of the consumer's information gap. In either case, the physician can charge more for the same service, with insurance companies paying most of the difference. One could also argue that information flows would be greater for surgery given the risks and costs involved, the necessity for informed consent, growing malpractice suits, etc. Also, a considerable amount of surgery is of an emergency nature, taking the decision out of both the patient's and the physician's hands. Pre-and post-operatve visits could be discretionary, but our study includes only whether an operation was performed.

Nevertheless, limited test of the Pauly-Satterthwaite increasing monopoly hypothesis had no effect on the results: it was physician concentration per capita, not per square mile, that contributed to higher utilization and fees.

In response to the criticism that shortage and surplus areas have been confounded, giving misleading positive correlations between physician supply, utilization, and fees, a disequilibrium approach was also tried. Even when shortage areas were removed, the positive shift effect remained, albeit to a slightly smaller degree.

Finally, as for the logical, convincing argument why and how physicians shift demand, our study is admittedly limited. We have not explored, in depth, the role of reference, or target, incomes, for example. Ours was a more limited goal of evaluating the evidence linking supply with demand, surgeons with utilization and fees, trying to address some of the more common criticisms of previous work. It is our interpretation of the findings that greater surgeon concentration definitely contributes to higher fees.

Ironically, equilibrium surgery rates may even decline, however, as surgical workloads dramatically fall with greater fees. Evidence for these findings comes mainly from the large metro areas where most surgeons are concentrated; nonurban markets exhibit behavior more consistent with neoclassical theory.

If the equilibrium results are taken at face value, support exists for the presence of backward-bending supply and target incomes. Downward fee rigidity, coupled with discretionary powers over fees, can under such circumstances lead to socially undesirable outcomes: higher fees and expenditures with limited access.

APPENDIX A : HEALTH INSURANCE COVERAGE VARIABLE

It had initially been planned to use biannual data collected from the Health Interview Survey to construct a health insurance coverage variable for analytic purposes. During even-numbered survey years, NCHS asks respondents whether or not each member had Medicare or private hospital insurance (Medicaid coverage was not asked until 1976), and we had intended to interpolate the remaining years. Independent analysis by Professor Frank Sloan, however, found disturbing temporal trends in the HIS health insurance data; some states displayed declining rates of coverage over time and many states showed a marked drop in coverage in 1974. Because of these findings, coupled with NCHS' own reports of validity problems with these data, we decided to construct alternative measures of health insurance coverage. Adequate time-series insurance information by small geographic area are non-existent. Instead an average coinsurance rate for hospital services was constructed by state for each of the years in our time-series. Then, using parameter estimates from a state insurance regression, a predicted coinsurance rate was generated for each PSU. This procedure is described in detail below.*

Empirical Specification and Estimation

Based on previous theoretical and empirical work on the demand for health insurance (Phelps, 1976), a state insurance regression was specified for use in generating predicted levels of insurance coverage for the PSUs. This regression was limited to those explanatory variables that also were available in HIS. Data sources for all variables in the equation are presented in Table

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*This work was conducted jointly by Professor Frank Sloan and the principal investigator.

A-1. All variables were defined by year at the state level.

Dependent Variable: The dependent variable was defined as the proportion of total hospital revenues reimbursed by third-party payors, or the average coinsurance rate. The denominator for this variable is total patient revenues for community general hospitals. The numerator is the sum of benefits paid to these hospitals by commercial insurors, Blue Cross plans, Medicare, and Medicaid. (Published state estimates of commercial and Blue Cross payments do not separate hospital from physician and other medical payments. They were adjusted for analytic purposes, using annual national estimates of the proportion of hospital benefits to total benefits by payor (commercial and Blue Cross).)

Explanatory Variables: Explanatory variables included industry mix, age distribution, racial composition, educational attainment,income, urbanization, state, and time.

Industry mix was defined as the proportion of all employed persons in the state working in the following industry groups : mining; contract construction; manufacturing; transportation and public utilities; wholesale and retail trade; finance, insurance, and real estate; and services and government. The proportion employed in agriculture constituted the omitted group.

Four age variables were specified with the youngest omitted; proportion of state population less than 21 years old, aged 21-44, aged 45-64, and 65 years and over. Racial composition was defined as the percent of population non-white. Education was specified as the mean percentage of population 25 years and older who had graduated from high school. Income was defined as state per capita income, adjusted for geographic cost-of-living differences.

TABLE A-1: VARIABLE DEFINITIONS AND DATA SOURCES FOR THE STATE HEALTH INSURANCE REGRESSION

VARIABLE	DEFINITION	DATA SOURCE
AVGCOIN	Average coinsurance rate, created as follows: $\text{AVGCOIN} = \dfrac{\text{MEDICAID} + \text{MEDICARA} + \text{BC} + \text{COMM}}{\text{HOSPREV}}$ Where	
	MEDICAID = Medicaid benefits to general hospitals for inpatient, outpatient, and clinic visits	Years 1969 -1974: Annual National Center for Social Statistics Reports (B-1) pub. by SRS. Years 1975 and 1976: *Data on the Medicaid Program: Eligibility, Services, Expenditures*, Medicaid/Medicare Management Institute, HCFA
	MEDICARA = Medicare Part A payments	Area Resource File
	BC = Blue Cross benefits paid to hospitals	*Source Book of Health Insurance Data*, Health Insurance Institute (Hospital payment adjustment from *Social Security Bulletin*)
	COMM = Commercial insurance company payments to hospitals	*Source Book of Health Insurance Data*, Health Insurance Institute (Hospital payment adjustment from *Social Security Bulletin*)
	HOSPREV = Net total revenue for community hospitals	American Hospital Association *Guide* Issues

TABLE A-1 (con't.): VARIABLE DEFINITIONS AND DATA SOURCES FOR THE STATE HEALTH INSURANCE REGRESSION

VARIABLE	DEFINITION	DATA SOURCE
MINING	Mining employment share of total employment	U.S. Dept. of Labor Statistics *Employment and Earnings, States and Areas 1939-1975*; *Employment and Earnings*, May, 1979
CONSTR	Contract construction employment share	
MFG	Manufacturing employment share	
TRANSP	Transportation and public utilities employment share	
TRADE	Wholesale and retail trade employment share	
FINANCE	Finance, insurance and real estate employment share	
SERVGOV	Services and government employment share	
%SMSA	Percent of population in SMSAs, interpolated for 1972-75	*Statistical Abstracts*
AGE21	Percent of population aged 21 years to 44 years	*Statistical Abstracts*
AGE45	Percent of population aged 45 years to 64 years	*Statistical Abstracts*
AGE65	Percent of population aged 65 years and older	*Statistical Abstracts*
NONWT	Percent of population non-white, interpolated for 1969, 1971-74, 1976	*Statistical Abstracts*
HSGRAD	Percent of population aged 25 and over that are high school graduates (mean of male and female high school graduate percentages), interpolated for years 1972-75	*Statistical Abstracts*
ADJPCY	Per capita income adjusted for geographic cost of living differences	*Statistical Abstracts*
D70 to D76	Dummy variables for years 1970 to 1976	
DST1 to DST50	Dummy variables for states, numbered alphabetically, including District of Columbia and excluding Wyoming	

(Construction of the cost-of-living index is described in Appendix B.) Urbanization was represented by the percent of population living in SMSAs.

State dummy variables (including D.C. and with Wyoming omitted) were used to capture unmeasured factors that may vary over time but are fixed with respect to each state, e.g. state insurance regulation. This fixed effects procedure allowed us to capture differences between states that were not measured by the explanatory variables specified above.

Finally, we included seven time dummies, rather than a trend factor, in order to capture nonlinearities. The base year (1969) was the omitted category.

Results

The final regression equation is displayed in Table A-2. It was highly successful, explaining 86 percent of the variance in average state coinsurance rates. Using the regression coefficients in Table A-2, we then estimated average coinsurance rates for each of the PSUs in our sample. These rates were then indexed to a base year PSU and the indexed rate used in the regression analysis.

Table A-2: Estimated Parameters from the State Health Insurance Regression

(t-statistics in parentheses)

$$
\begin{aligned}
\text{AVGCOIN} = {} & - 0.0115 + \underset{(1.40)}{0.8898\ \text{MINING}} - \underset{(1.45)}{0.4549\ \text{CONSTR}} + \underset{(0.35)}{0.0945\ \text{MFG}} - \underset{(0.61)}{0.3400\ \text{TRANSP}} - \underset{(0.81)}{0.5370\ \text{TRADE}} + \underset{(1.52)}{2.0445\ \text{FINANCE}} \\
& + \underset{(1.64)}{0.1461\ \text{SERVGOV}} - \underset{(o.93)}{0.5729\ \text{\%SMSA}} + \underset{(4.39)}{2.8536\ \text{AGE 21}} + \underset{(2.91)}{3.1122\ \text{AGE 45}} + \underset{(0.15)}{0.2187\ \text{AGE 65}} - \underset{(1.09)}{0.7860\ \text{NONWT}} \\
& - \underset{(3.69)}{0.7646\ \text{HS GRAD}} - \underset{(2.22)}{0.000036\ \text{ADJPCY}} + \underset{(0.92)}{0.0081\ \text{YEAR 70}} - \underset{(0.81)}{0.0120\ \text{YEAR 71}} - \underset{(0.87)}{0.0167\ \text{YEAR 72}} + \underset{(0.58)}{0.0138\ \text{YEAR 73}} \\
& - \underset{(0.52)}{0.0145\ \text{YEAR 74}} + \underset{(0.49)}{0.0169\ \text{YEAR 75}} - \underset{(0.00)}{0.0004\ \text{YEAR 76}} + \underset{(0.60)}{0.2675\ \text{AL}} + \underset{(1.00)}{0.3359\ \text{AK}} + \underset{(0.58)}{0.2687\ \text{AZ}} + \underset{(0.34)}{0.0977\ \text{AS}} \\
& + \underset{(1.03)}{0.5891\ \text{CA}} + \underset{(0.83)}{0.4023\ \text{CO}} + \underset{(0.82)}{0.4381\ \text{CT}} + \underset{(1.37)}{0.6058\ \text{DE}} + \underset{(1.15)}{1.0311\ \text{DC}} + \underset{(0.74)}{0.4146\ \text{FL}} + \underset{(0.65)}{0.2724\ \text{GA}} + \underset{(1.38)}{1.0038\ \text{HI}} \\
& + \underset{(0.75)}{0.0780\ \text{ID}} + \underset{(0.82)}{0.4170\ \text{IL}} + \underset{(1.01)}{0.4147\ \text{IN}} + \underset{(0.98)}{0.2151\ \text{IA}} + \underset{(1.16)}{0.3276\ \text{KA}} + \underset{(0.33)}{0.0967\ \text{KY}} + \underset{(0.57)}{0.2701\ \text{LA}} + \underset{(0.77)}{0.1141\ \text{ME}} \\
& + \underset{(0.93)}{0.5186\ \text{MD}} + \underset{(0.82)}{0.4224\ \text{MA}} + \underset{(1.23)}{0.6242\ \text{MI}} + \underset{(0.63)}{0.2416\ \text{MN}} + \underset{(0.57)}{0.1874\ \text{MI}} + \underset{(0.76)}{0.3090\ \text{MO}} + \underset{(0.71)}{0.1091\ \text{MT}} + \underset{(0.62)}{0.1637\ \text{NE}} \\
& + \underset{(0.39)}{0.1962\ \text{NV}} + \underset{(0.68)}{0.1425\ \text{NH}} + \underset{(0.90)}{0.5205\ \text{NJ}} + \underset{(0.72)}{0.1636\ \text{NM}} + \underset{(0.89)}{0.5006\ \text{NY}} + \underset{(0.38)}{0.1315\ \text{NC}} + \underset{(0.69)}{0.1053\ \text{ND}} + \underset{(1.00)}{0.4879\ \text{OH}} \\
& + \underset{(0.94)}{0.3354\ \text{OK}} + \underset{(1.01)}{0.3630\ \text{OR}} + \underset{(0.79)}{0.3901\ \text{PA}} + \underset{(0.89)}{0.4856\ \text{RI}} + \underset{(0.63)}{0.2460\ \text{SC}} + \underset{(0.41)}{0.0484\ \text{SD}} + \underset{(0.24)}{0.1014\ \text{TN}} + \underset{(0.76)}{0.3756\ \text{TX}} \\
& + \underset{(1.07)}{0.5103\ \text{UT}} - \underset{(0.47)}{0.0399\ \text{VT}} + \underset{(0.54)}{0.2381\ \text{VA}} + \underset{(1.21)}{0.5224\ \text{WA}} - \underset{(0.47)}{0.1107\ \text{WV}} + \underset{(1.04)}{0.3776\ \text{WI}}
\end{aligned}
$$

$R^2 = 0.88$

$R^2(c) = 0.86$

$F = 35.88$

APPENDIX B: COST-OF-LIVING ADJUSTMENT

In time series analysis, it is clearly important to deflate monetary variables, and express them in real, rather than nominal, dollars. As physicians tend to locate in high cost-of-living areas, it is also important to adjust fees and other monetary variables for geographic cost-of-living differences. Failure to do so may bias physician-population ratio coefficients upwards.

Cost-of-living deflators were not available for all of the areas included in our sample of PSUs, and so we developed our own index, using the methodology developed by the Institute of Medicine for this purpose (IOM, 1976).* Annual Bureau of Labor Statistics estimates of an intermediate budget for a family of four were available for non-SMSAs (by region) and for 39 SMSAs. In order to derive budgets for the remaining 100+ SMSAs in the HIS sample, a predictive equation was developed from a cross-section time-series of the 39 SMSAs. Budget data were regressed on SMSA population, per capita income, and geographic regional dummies (with the South as the omitted category). Seven time dummy variables (with the year 1976 omitted) were also included. The resulting regression equation (shown below) yielded a corrected R-square of 0.92.

$$\begin{aligned} \text{BUDGET} = {} & 10312.5 + 0.0014\ \text{POP} + 0.9634\ \text{INC} \\ & + 1366.3\ \text{NEAST} + 572.9\ \text{NCEN} + 855.9\ \text{WEST} \\ & - 4000.8\ \text{Y69} - 3585.7\ \text{Y70} - 3478.9\ \text{Y71} \\ & - 3287.2\ \text{Y72} - 2341.5\ \text{Y73} - 1084\ \text{Y74} \\ & - 486.3\ \text{Y75} \end{aligned}$$

Parameter estimates from this equation were used to generate a budget for each of the remaining SMSAs in the sample. The cost-of-living index was then developed, using the 1969 national urban budget as the base. All monetary variables are expressed in 1969 dollars.

---

*All of the monetary variables were adjusted by the total price index, and not by the medical care component. Geographic differences in the medical care portion of the CPI will include any inducement effects; deflating surgical fees in this manner would bias any test of shift.

APPENDIX C: ELECTIVE SURGERY: CONCEPTUAL AND OPERATIONAL MEASUREMENT

Table II-1 illustrated the differential rates of increase for selected operations over time and geographic variations in those procedures, but it did not distinguish elective from non-elective operations. Elective surgery, however, may be particularly sensitive to demand-shifting, as physicians presumably have greater discretionary influence over these procedures. Elective surgery rates per capita thus should show larger increases over time as well as greater geographic variation. It is first neccessary to define elective surgery and then to operationalize this definition in terms of specific procedures.

Previous Definitions of Elective Surgery

In recent years, second opinion surgery programs have been implemented by third party payors to assess the necessity of elective operations. Prospective denial of unwarranted surgery under such programs is assumed to both lower costs and improve quality. In order to do this, programs have had to first develop administrative procedures for defining elective surgery. Some programs (e.g., Blue Cross/Blue Shield of Greater New York) simply determine whether the proposed surgery is elective (and hence eligible for a second opinion review) on a case by case basis. The only predetermined criterion is that the operation be a non-emergency procedure. Other programs require a second opinion on only a limited set of surgical procedures. The Massachusetts Medicaid program, for example, has selected eight operations for their demonstration project.* This subset was chosen because there is considerable divergence of medical opinion regarding the indications for their performance, and their necessity for any given patient. If deemed successful, the program presumably will be expanded to include a wider range of operations.

---

*Tonsillectomy and/or adenoidectomy, submucous resection/rhinoplasty, cholecystectomy, hemmorhoidectomy, spinal fusion/disc surgery, menisectomy, and varicose vein excision. All of these procedures are also included in the Cornell list.

A third approach has been to define elective surgery *a priori* and mandate review for a comprehensive list of operations meeting that definition. The Cornell Second Opinion Program, for example, has defined elective surgery as:

> "Operations or surgical procedures which are not considered to be emergency or life-threatening and are subject to the choice of the patient and physician. Specifically excluded are surgeries required as a result of trauma, normal vaginal deliveries, cesarean sections, and elective abortions."

Based on this definition, a list of specific operations have been identified as requiring presurgery screening. This list was developed by consensus of surgeons at eight major New York City teaching hospitals. It includes those operations commonly considered "elective," such as hysterectomies and tonsillectomies, as well as a wider range of discretionary procedures, e.g., all heart surgery, all operations on kidneys and bladder, etc.

Defining Elective Surgery from HIS Data

Conceptual Measurement

Elective surgery will be conceptually defined as those operations which meet the following criterion:

(1) They can be scheduled in advance, i.e., they are not emergency procedures.

In addition, at least one of the following must be met:

(2) They are discretionary on the part of both physician and patient, in that lack of surgery poses only a morbidity, not a mortality, threat to the patient; and/or

(3) The scientific evidence does not indicate clearly greater average life expectancy if surgical treatment is chosen.

Thus surgery required as the result of trauma is excluded. Obstetric procedures, including Cesarean sections and elective abortions, are also excluded as they are a direct function of conception and birth rates.*

This definition of elective surgery has several advantages for a study of demand-shifting. First, it explicitly excludes operations that result from accidents, violence, and childbearing, phenomena that are out of the physician's control, as well as (to a somewhat lesser extent) that of the patient. Second, it is limited to procedures for which non-surgical alternatives (including no treatment) can be considered by both the patient and his physician. In cases of acute appendicitis, the patient faces an immediate threat of death without surgery. The patient with coronary artery disease, on the other hand, frequently has an alternative to coronary artery bypass surgery: treatment with drugs. Similarly, the woman with menstrual irregularities can choose to cope with associated disconforts rather than undergo a hysterectomy.

Most physicians would probably agree with this conceptual definition of elective surgery. Substantial divergence of opinion would probably arise, however, over which procedures were considered discretionary in nature. If physicians are able to induce demand for surgical services, furthermore, they may adjust their definitions of elective surgery accordingly. The number of procedures deemed elective thus may be inversely related with the extent of demand shifting (and hence with the supply of surgeons). The operational measurement of elective operations therefore should not reflect local community standards of what constitutes discretionary surgery.

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*The large increase in births via cesarean section in recent years suggests that physicians may exert considerable discretionary influence over this procedure as well.

Operational Measurement

The Health Interview Survey includes hospitalization data for all respondents during the preceding twelve months. The following information is collected for each hospital admission: length of stay, diagnosis or medical condition, and name of surgical operation(s), if any.

As these data are based on patient self-reports, the codes are not sufficiently detailed to permit ICDA classification. (The validity of patient self-reported data and possible field bias were discussed in Chapter V.) The HIS codes range from simply naming the organ or body part (e.g., operations on bladder) to a general description of the procedure (e.g., operations for hernia) to a more specific surgical definition (e.g., tonsillectomy). The medical condition necessitating hospital admission can be used to derive a specific surgical procedure from the larger category. Thus, a diagnosis of cataracts can be used to separate lens extraction from other operations on the eye. Similarly, the operation category "D&C" can be purged of all procedures related to abortions or deliveries. (All obstetric procedures, including abortions, will be excluded from the analysis entirely and not counted in total surgery rates.)

The HIS surgery codes were classified as elective or non-elective, based on the conceptual definition described above, by a panel of physicians at Boston University Medical Center. Any operations resulting from trauma or associated with a cancer diagnosis, including those in the "definitely elective" category, were considered non-discretionary surgery. The HIS distinguishes between recent accidents or injuries and those occurring more than three months prior to the operation. Only recent injuries were considered traumatic conditions; surgery performed to correct chronic impairments were defined as elective, provided that all other criteria were met. Thus, operations for knee derangement (HIS code 85) were classified as elective surgery, unless the knee injury was received within the past three months.

The HIS surgery codes were grouped in the following categories:

(1) Definitely elective: surgical procedures considered under our definition to usually be discretionary, e.g., tonsillectomy, varicose vein excision, etc.

(2) Definitely non-elective: operations generally performed on a non-discretionary basis, such as most neurological procedures.

(3) Uncertain: procedures considered discretionary by the Cornell Program, but around which there may be less medical consensus. Examples include cardiac surgery and operations on the bladder.*

Table C-1 lists the surgical procedures and their HIS codes in terms of these categories. Figure C-1 outlines the procedure used in actually classifying the individual into the three categories.

---

*Some of the HIS categories have been classified as uncertain, because they include a mix of procedures (both elective and non-elective).

TABLE C-1

CLASSIFICATION OF HIS OPERATION CODES FOR ELECTIVE SURGERY

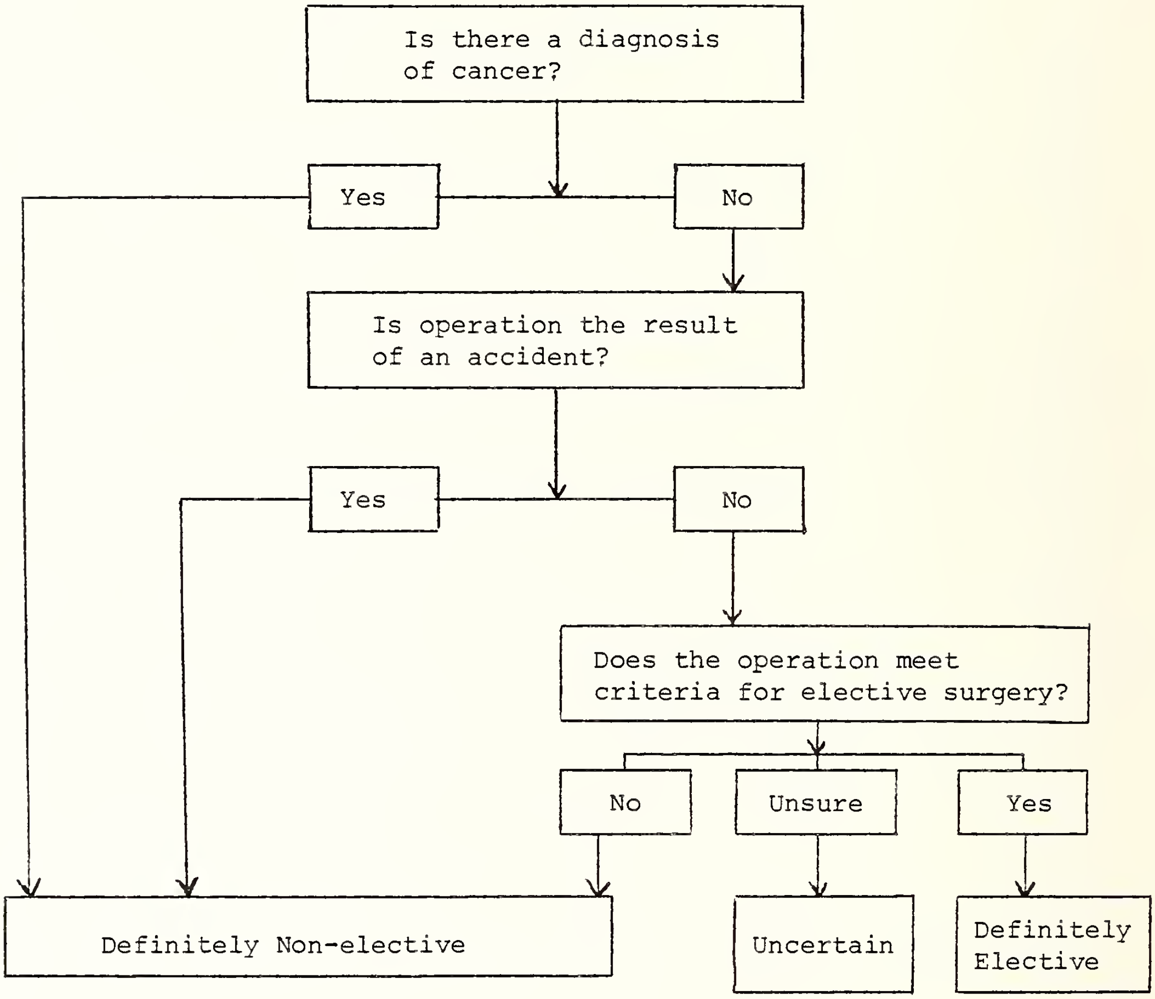
Operation	Definitely Elective	Uncertain	Definitely Non-Elective
Endocrine	--	Thyroidectomy (01) Other operations on thyroid gland (02) Operations on other endocrine glands (09)	--
Nervous System	Operations on spinal cord and spinal meninges (13) Other operations on nervous system (14)	Surgical treatment and tests for mental and nerve disorders (10)	Operations on brain and cerebral meninges (11) Operations on skull or cranium (12)
Eye, Ear	Operations on eye, any part (20) Operations on ear (25) Operations involving mastoid process (26)	--	--
Cardiovascular	Operations for varicose veins (31)	Operations on heart (30) Operations on arteries, veins, capillaries (32)	--
Lymph, Spleen Bone Marrow	--	--	Operations on lymph system, spleen, bone marrow (49)
Respiratory	Tonsillectomy and/or adenoidectomy (50) Operations on nose or nasopharynx (52)	Other operations on throat, tonsils (51) Operations on sinuses (53)	Operations on lung and and pleura (54) Operations on other sites of respiratory system (59)

TABLE C-1 (continued)

Operation	Definitely Elective	Uncertain	Definitely Non-Elective
Digestive/ Abdominal	Operations on teeth and gums (60) Operations on other sites of buccal cavity (61) Operations for hernia (65) Operations for hemmorrhoids (67) Operations on gallbladder or gall ducts (69)	Operations for ulcer of stomach, duodenum or jejeunum (62) Other operations on stomach, deudoenum or jejeunum (63) Operations on digestive system not elsewhere classified (NEC) and abdominal regions NEC (6X)	Operations for appendicitis (64) Operations on intestines not elsewhere classified (NEC), rectum NEC (66) Operations on liver (68)
Genito-urinary and Breast	Circumcision (72) Operations on prostate (73) Other operations on breast (76) Hysterectomy (77) D and C (78) Other operations on female genital organs (79)	Operations on bladder (71) Other operations on male genital organs (74) Other genito-urinary operations NEC (7X)	Operations on kidneys (70) Mastectomy (75)
Skin and Musculoskeletal	Operations for pilonidal cyst (81) Other operations on skin and subcutaneous tissue (82) Operations for dislocations of joint NEC (84) Operations for knee derangement (85) Operations for spinal "disc" conditions (86)	Operations for fractures of bones NEC (81) Other operations on bone (89)	Skin graft (80) Amputation of finger(s), toe(s), (87) Amputation of arm(s), leg(s) (88)

Figure C-1

PROCEDURE FOR HIS OPERATIONS CODE CLASSIFICATION


Is there a diagnosis of cancer?
Yes
No
Is operation the result of an accident?
Yes
No
Does the operation meet criteria for elective surgery?
No
Unsure
Yes
Definitely Non-elective
Uncertain
Definitely Elective

APPENDIX D:

COMPLETE 2SLS REGRESSIONS FOR NON-METROPOLITAN, SMALL, AND LARGE METROPOLITAN AREAS

TABLE D-1:

TWO-STAGE LEAST SQUARES REGRESSIONS: NON-METROPOLITAN PSUs, 1969-1976
(t-values in parentheses)

INDEPENDENT VARIABLE	DEPENDENT VARIABLE SR (1)	SRE (2)	P (3)	$\bar{P}$ (4)	W (5)	SP (6)
P	-0.043	-0.017	--	--	0.784	0.0014
	(1.7)*	(1.0)			(1.1)	(7.0)**
SP	5.49	3.60	44.4	-215.9	-718.1	--
	(0.6)	(0.6)	(0.5)	(3.2)**	(2.1)**	
W	--	--	--	--	--	-0.00008
						(4.7)**
SR	--	--	-8.67	--	--	--
			(2.8)**			
ELDPC	48.5	14.1	396.0	18.0	--	--
	(2.7)**	(1.2)	(1.8)*	(0.4)		
MIDPC	-5.7	-24.0	-57.0	46.6	--	--
	(0.3)	(2.1)**	(0.4)	(0.1)		
YAPC	-5.3	3.77	-62.3	-4.4	--	--
	(0.3)	(0.3)	(0.4	(0.1)		
F	8.7	21.1	104.9	77.6	--	--
	(0.5)	(1.7)*	(0.6)	(1.8)*		
WHITE	8.6	8.0	8.5	-92.8	--	--
	(1.5)	(2.2)**	(0.1)	(8.2)**		
EDHS	18.7	8.8	135.4	-13.4	--	--
	(2.5)**	(1.9)*	(1.5)	(0.7)		
EDCL	3.2	-1.2	42.1	93.1	--	--
	(0.3)	(0.2)	(0.5)	(3.5)**		
DISPC	20.9	8.4	206.5	26.6	--	--
	(4.5)**	(2.8)**	(2.9)**	(2.6)**		
INC (000)	1.04	0.52	13.5	6.7	--	--
	(2.9)**	(2.3)**	(3.8)**	(9.2)**		
COIN	8.18	4.59	91.2	23.5	--	--
	(2.9)**	(2.1)**	(2.5)**	(3.2)**		
HEXPA (00)	0.21	0.14	4.33	4.30	--	--
	(0.6)	(0.6)	(1.4)	(5.3)**		
EMP	8.8	4.6	39.7	-38.6	--	--
	(0.9)	(0.8)	(0.4)	(1.8)*		
PROF	-3.8	-0.8	-36.9	36.3	--	--
	(0.3)	(0.1)	(0.3)	(1.1)		
CLERK	9.3	11.0	49.3	4.0	--	--
	(0.8)	(1.5)	(0.5)	(0.1)		

TABLE D-1, cont.

TWO-STAGE LEAST SQUARES REGRESSIONS: NON-METROPOLITAN PSUs, 1969-1976
(t-values in parentheses)

INDEPENDENT VARIABLE	DEPENDENT VARIABLE					
	SR (1)	SRE (2)	P (3)	$\bar{P}$ (4)	W (5)	SP (6)
BLUEC	11.4	8.3	90.9	18.0	--	--
	(1.4)	(1.6)	(1.1)	(0.7)		
GPPC	-10.9	-7.6	-100.8	-76.0	9.6	--
	(1.5)	(1.6)	(1.4)	(2.8)**	(0.0)	
NSP	2.1	0.2	-18.5	-32.1	590.4	
	(0.5)	(0.1)	(0.5)	(2.6)**	(4.5)**	
BEDPC	--	--	--	4.04	-31.36	0.02
				(2.4)**	(2.5)**	(14.5)**
WAGE	--	--	--	41.5	-94.6	0.03
				(7.9)**	(1.5)	(3.1)**
SMSA	--	--	--	--	--	-0.05
						(0.1)
DEGDAYS (000)	--	--	--	--	--	0.02
						(7.2)**
COLLG	--	--	--	--	--	0.04
						(9.3)**
HOTLPC	--	--	--	--	--	-0.04
						(1.5)
TIME	0.77	-0.01	3.86	-3.82	3.19	0.009
	(2.44)**	(0.1)	(1.0)	(5.6)**	(0.4)	(6.2)**
CONST	12.6	-5.5	332.8	191.0	616.2	-0.50
	(0.7)	(0.4)	(2.2)**	(3.6)**	(2.8)**	(8.0)**
R^2	0.08	0.06	0.02	0.21	0.06	0.37
(F)	(7.1)	(4.8)	(1.5)	(20.5)	(14.1)	(104.9)

---

* Significant at ten percent level.

** Significant at five percent level.

TABLE D-2:

TWO-STAGE LEAST SQUARES REGRESSIONS: SMALL METROPOLITAN PSUs, 1969-1976
(t-values in parentheses)

INDEPENDENT VARIABLE	DEPENDENT VARIABLE					
	SR (1)	SRE (2)	P (3)	$\bar{P}$ (4)	W (5)	SP (6)
P	0.004 (0.1)	0.013 (0.6)	--	--	-0.047 (0.4)	0.0002 (0.8)
SP	5.57 (0.2)	12.65 (0.8)	-66.1 (1.4)	459.1 (4.4)**	-667.4 (8.4)**	--
W	--	--	--	--	--	-0.001 (7.3)**
SR	--	--	0.51 (0.6)	--	--	--
ELDPC	5.96 (0.2)	-29.1 (1.3)	149.9 (2.2)**	-78.4 (0.9)	--	--
MIDPC	94.5 (3.3)**	18.3 (1.0)	-21.9 (0.2)	-106.8 (1.6)	--	--
YAPC	56.9 (1.9)*	3.0 (0.2)	70.9 (1.0)	11.0 (0.2)		
F	-17.3 (0.6)	14.6 (0.1)	114.1 (1.9)*	44.5 (0.7)	--	--
WHITE	19.7 (2.0)**	11.1 (1.7)*	-101.7 (4.2)**	-64.5 (3.1)**	--	--
EDHS	24.1 (1.8)*	10.2 (1.2)	-102.9 (3.2)**	-85.1 (3.1)**	--	--
EDCL	-7.5 (0.5)	0.1 (0.0)	-82.1 (2.7)**	-176.5 (4.8)**	--	--
DISPC	18.7 (2.4)**	2.2 (0.4)	48.9 (2.3)**	52.3 (3.4)**	--	--
INC (000)	0.64 (1.2)	0.49 (1.4)	2.04 (1.8)*	4.27 (3.7)**	--	--
COIN	-4.5 (0.7)	1.0 (0.3)	-1.4 (0.1)	19.5 (1.5)	--	--
HEXPA (00)	-0.43 (1.1)	-0.26 (1.1)	0.75 (0.9)	1.27 (1.5)	--	--
EMP	-37.6 (2.1)**	-26.5 (2.3)**	5.5 (0.1)	-104.4 (2.6)**	--	--
PROF	33.1 (1.2)	20.1 (1.1)	-276.9 (4.8)**	-210.5 (3.7)**	--	--
CLERK	27.2 (1.0)	19.4 (1.1)	-246.5 (4.7)**	-182.3 (3.4)**	--	--
BLUEC	30.9 (1.1)	26.9 (1.5)	-405.0 (7.7)**	-244.9 (4.3)**	--	--

TABLE D-2, cont.

TWO-STAGE LEAST SQUARES REGRESSIONS: SMALL METROPOLITAN PSUs, 1969-1976
(t-values in parentheses)

INDEPENDENT VARIABLE	DEPENDENT VARIABLE					
	SR (1)	SRE (2)	P (3)	$\bar{P}$ (4)	W (5)	SP (6)
GPPC	-15.0	-3.6	20.0	81.9	51.8	--
	(0.9)	(0.3)	(0.6)	(2.2)**	(1.0)	
BEDPC	--	--	--	-12.97	6.07	0.015
				(5.8)**	(2.3)**	(6.2)**
WAGE	--	--	--	0.78	-2.65	-0.004
				(0.5)	(1.1)	(1.4)
SMSA	--	--	--	--	--	0.02
						(0.5)
DEGDAYS (000)	--	--	--	--	--	0.001
						(0.3)
COLLG	--	--	--	--	--	0.002
						(0.7)
HOTLPC	--	--	--	--	--	0.01
						(0.4)
TIME	-0.34	-0.33	-2.17	-1.16	0.31	0.001
	(0.7)	(1.1)	(2.4)**	(1.2)	(0.2)	(0.8)
CONST	-10.4	-9.8	620.2	532.0	426.1	0.39
	(0.3)	(0.4)	(9.5)**	(7.2)**	(11.3)**	(3.2)**
R^2	0.06	0.03	0.23	0.22	0.18	0.35
(F)	(2.1)	(1.1)	(10.4)	(9.7)	(25.5)	(41.3)

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* Significant at ten percent level.

** Significant at five percent level.

TABLE D-3:

TWO-STAGE LEAST SQUARES REGRESSIONS: LARGE METROPOLITAN PSUs, 1969-1976
(t-values in parentheses)

INDEPENDENT VARIABLE	DEPENDENT VARIABLE					
	SR (1)	SRE (2)	P (3)	$\bar{P}$ (4)	W (5)	SP (6)
P	-0.037 (1.7)*	-0.032 (2.2)**	--	--	-0.177 (5.0)**	-0.00008 (1.0)
SP	25.31 (1.2)	14.21 (1.0)	534.1 (4.3)**	679.9 (6.7)**	-395.0 (10.1)**	--
W	--	--	--	--	--	-0.0016 (9.1)**
SR	--	--	-5.27 (3.0)**	--	--	--
ELDPC	57.3 (1.9)*	-1.0 (0.0)	268.5 (1.2)	-69.5 (0.5)	--	--
MIDPC	14.1 (0.5)	2.7 (0.1)	-162.7 (0.9)	-308.6 (2.3)**	--	--
YAPC	5.4 (0.2)	1.0 (0.0)	-112.3 (0.5)	-262.5 (1.7)*	--	--
F	-6.8 (0.2)	23.3 (1.1)	15.4 (0.1)	95.6 (0.6)	--	--
WHITE	7.8 (1.2)	5.2 (1.2)	6.3 (0.1)	-19.6 (0.6)	--	--
EDHS	10.4 (0.7)	-2.6 (0.3)	-130.6 (1.3)	-242.3 (3.4)**	--	--
EDCL	9.1 (0.6)	-14.3 (1.3)	-142.0 (1.3)	-328.4 (4.1)**	--	--
DISPC	18.6 (2.3)**	2.8 (0.5)	134.2 (2.1)**	20.4 (0.5)	--	--
INC (000)	0.38 (0.9)	-0.07 (0.3)	14.1 (7.4)**	13.3 (9.4)**	--	--
COIN	-7.0 (2.2)**	-4.9 (2.3)**	-20.7 (0.8)	-23.0 (1.3)	--	--
HEXPA (00)	-0.23 (4.9)**	-0.09 (2.8)**	-0.27 (0.5)	1.34 (6.6)**	--	--
EMP	-10.6 (0.7)	-11.8 (1.2)	-205.3 (2.2)**	-137.4 (2.0)**	--	--
PROF	-13.3 (0.4)	-15.9 (0.8)	-573.5 (3.1)**	-531.6 (3.9)**	--	--
CLERK	12.7 (0.5)	-12.4 (0.8)	-393.3 (2.6)**	-493.7 (4.8)**	--	--
BLUEC	-3.6 (0.1)	-24.6 (1.3)	-429.4 (2.5)**	-443.2 (3.5)**	--	--
GPPC	-26.5 (1.9)*	-3.1 (0.3)	219.3 (2.1)**	461.2 (8.6)**	-26.8 (.8)	--

TABLE D-3, cont.

TWO-STAGE LEAST SQUARES REGRESSIONS: LARGE METROPOLITAN PSUs 1969-1976
(t-values in parentheses)

INDEPENDENT VARIABLE	DEPENDENT VARIABLE					
	SR (1)	SRE (2)	P (3)	$\bar{P}$ (4)	W (5)	SP (6)
BEDPC	--	--	--	-17.3	1.40	0.105
				(5.3)**	(0.8)	(3.8)**
WAGE	--	--	--	7.55	3.71	0.003
				(2.2)**	(1.8)*	(1.0)
SMSA	--	--	--	--	--	-0.04
						(0.9)
DEGDAYS (000)	--	--	--	--	--	-0.004
						(1.5)
COLLG	--	--	--	--	--	-0.001
						(4.6)**
HOTLPC	--	--	--	--	--	-0.09
						(0.8)
TIME	0.21	-0.07	5.63	7.52	1.50	0.003
	(0.6)	(0.3)	(2.6)**	(4.7)**	(2.1)**	(2.8)**
CONST	55.1	55.3	944.7	792.1	365.8	0.68
	(1.4)	(2.1)**	(3.9)**	(4.5)**	(26.4)**	(13.5)**
R^2	.23	0.14	.35	.50	.36	.42
(F)	(8.3)	(4.6)	(14.8)	(26.7)	(50.0)	(42.3)

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* Significant at ten percent level.

** Significant at five percent level.

APPENDIX E:

TEST OF PAULY-SATTERTHWAITE INCREASING MONOPOLY MODEL

TABLE E-1:

TWO-STAGE LEAST SQUARES REGRESSIONS, WITH SURGDEN ADDED: ENTIRE PSU SAMPLE, 1969-1976

(t-values in parentheses)

INDEPENDENT VARIABLE	DEPENDENT VARIABLE						
	SR (1)	SRE (2)	P (3)	$\bar{P}$ (4)	W (5)	SP (6)	SURGDEN (7)
P	-0.024	-0.016	--	--	0.15	0.0002	0.004
	(1.9)*	(2.0)**			(0.7)	(1.2)	(10.6)**
SP	13.31	13.05	423.8	1295.5	-1080.4	--	--
	(2.3)**	(2.3)**	(3.0)**	(12.1)**	(8.9)**		
W	--	--	--	--	--	-0.0003	0.0006
						(9.6)**	(6.2)**
SR	--	--	-14.9		--	--	--
			(3.2)**				
SURGDEN	-3.94	0.02	-37.9	-118.0	-21.8	--	--
	(1.27)	(0.0)	(0.7)	(5.2)**	(1.0)		
ELDPC	46.7	3.3	626.0	-306.9	--	--	--
	(3.4)**	(0.4)	(2.0)**	(3.6)**			
MIDPC	25.8	-6.1	306.6	-305.1	--	--	--
	(2.0)**	(0.7)	(1.3)	(3.8)**			
YAPC	13.6	3.9	169.0	-236.3	--	--	--
	(1.0)	(0.4)	(0.8)	(2.9)**			
F	-4.7	18.5	-39.8	-48.0	--	--	--
	(0.3)	(2.0)**	(0.2)	(0.6)			
WHITE	10.0	8.7	93.5	-111.8	--	--	--
	(2.8)**	(3.7)**	(1.2)	(5.4)**			
EDHS	21.0	11.3	233.3	-315.8	--	--	--
	(3.7)**	(3.1)**	(1.7)*	(8.6)**			
EDCL	0.4	-4.4	-27.7	-478.5	--	--	--
	(0.1)	(0.9)	(0.3)	(8.3)**			
DISPC	20.3	5.8	347.1	37.6	--	--	--
	(5.8)**	(2.6)**	(3.4)**	(1.8)*			
INC (000)	0.78	0.21	17.5	12.0	--	--	--
	(3.6)**	(1.5)	(4.4)**	(10.1)**			
COIN	0.6	0.2	29.5	73.2	--	--	--
	(0.3)	(0.2)	(1.2)	(6.8)**			
HEXPA (00)	-0.09	-0.07	-1.27	4.58	--	--	--
	(0.9)	(1.0)	(0.7)	(6.1)**			
EMP	-2.6	-5.3	-139.5	-255.7	--	--	--
	(0.4)	(1.1)	(1.4)	(6.1)**			
PROF	-2.8	1.6	-149.2	-553.2	--	--	--
	(0.3)	(0.2)	(1.0)	(8.1)**			
CLERK	12.1	8.1	58.4	-557.4	--	--	--
	(1.4)	(1.4)	(0.4)	(9.2)**			
BLUEC	9.5	6.5	47.8	-411.2	--	--	--
	(1.3)	(1.4)	(0.4)	(8.5)**			

TABLE E-1 (cont'd):

TWO-STAGE LEAST SQUARES REGRESSIONS, WITH SURGDEN ADDED: ENTIRE PSU SAMPLE, 1969-1976 (t-values in parentheses)

INDEPENDENT VARIABLE	DEPENDENT VARIABLE						
	SR (1)	SRE (2)	P (3)	$\overline{P}$ (4)	W (5)	SP (6)	SURGDEN (7)
GPPC	-13.1	-7.2	-87.7	436.8	--	--	--
	(2.3)**	(1.9)*	(0.8)	(10.9)**			
NSP	1.5	3.0	52.8	199.3	633.4	--	--
	(0.4)	(1.1)	(0.9)	(7.3)**	(6.7)**		
BEDPC	--	--	--	-30.2	-9.1	0.013	0.029
				(11.7)**	(1.6)	(5.8)**	(4.9)**
WAGE	--	--	--	-0.7	-2.0	0.01	-0.01
				(0.3)	(0.2)	(1.2)	(1.2)
SMSA	--	--	--	--	--	0.06	0.26
						(5.2)**	(8.2)**
DEGDAYS (000)	--	--	--	--	--	-0.005	0.05
						(1.8)*	(7.0)**
COLLG	--	--	--	--	--	0.0001	0.03
						(0.3)	(26.8)**
HOTLPC	--	--	--	--	--	-0.03	-0.17
						(1.0)	(1.7)*
TIME	0.32	-0.19	4.99	3.63	3.29	0.003	-0.002
	(1.7)*	(1.5)	(1.5)	(3.1)**	(0.9)	(2.3)**	(0.6)
CONST	16.5	7.2	569.4	967.4	572.4	0.24	-1.87
	(1.1)	(0.7)	(2.8)**	(10.6)**	(7.5)**	(4.1)**	(11.4)**
R^2	.09	.05	.02	.15	.14	.30	.50
(F)	(13.4)	(7.2)	(3.1)	(21.9)	(65.8)	(132.8)	(315.8)

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* Significant at ten percent level.

** Significant at five percent level.

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